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REPORT

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AN EXPLORATION

OF THE

COALFIELDS OF NORTH CAROLINA,

MADE FOR THE

STATE BOARD OF AGRICULTURE.

BY H. M. CHANCE.

WITH THREE PLATES, AND THIRTEEN CUTS IN THE TEXT.

PUBLISHED BY ORDER OF THE BOARD.

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His Excellency, A. M. SCALES,

Chairman of Board of Agriculture:

SIR:—Herewith is submitted the report of Dr. H. M. Chance on the exploration of the Deep and Dan River Coalfields, made by order of the Board of Agriculture, under the supervision of the undersigned.

Very respectfully,

MONTFORD McGEHEE,

Commissioner.

LETTER OF TRANSMITTAL.

GREENSBORO, N. C., April 10, 1885.

MONTFORD McGEHEE, ESQ., *Commissioner of Agriculture,*
Raleigh, North Carolina:

SIR:—I have the honor to submit the accompanying report on the Coal Explorations made by authority of the Board of Agriculture. The work was commenced July 4th, 1884, and practically finished by December 31st, 1884, although some little work was done at a later date.

I desire to express my gratitude to Governor Jarvis and the members of the Board of Agriculture for the interest they have taken in this work, and for the cordial support and assistance received from all with whom I have come in contact, and more especially, sir, to you, for the consideration and many kindly favors I have received at your hands.

Very respectfully yours,

H. M. CHANCE.

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REPORT ON AN EXPLORATION

OF THE

Coalfields of North Carolina.

CHAPTER I.

INTRODUCTION.

This report is based upon facts ascertained by an exploration authorized by the State Board of Agriculture. This exploration differs materially from examinations as commonly made under governmental authority, which are usually limited to an ocular inspection of those ores, minerals and rocks exposed to view, in that the work has been prosecuted by actual excavations, by pits, shafts, slopes, and bore-holes sunk to open the coal for examination and to discover its variations in thickness, to prove its persistence and to secure true average samples for analysis and practical tests.

In the organization of this coal and a similar phosphate exploration, North Carolina establishes what may prove a valuable precedent for the prosecution of similar work in other States. It will be readily admitted that this is a progressive step,—a bold and progressive movement far in advance of all other governmental work of its class.

A preliminary examination was first made in April, May and June, 1884, to determine the approximate cost of the proposed exploratory work, the character of this work and the methods best suited to the speedy attainment of the object in view. The actual explorations were commenced July 4th, 1884, and finished by December 31st, 1884, although some little work was done in March, 1885.

The actual cost of the exploration, exclusive of compensation paid the writer, was less than $1,800.00.

In the method adopted, the re-opening of all the old pits, shafts, and slopes sunk in the past, and which with few exceptions had fallen in so that the coal was hidden from view, was contemplated as the first necessary operation, to be followed by new openings made on the coal at points that seemed to require further examination.

All the work was done by hand, this, under the circumstances, being both cheaper and quicker than horse or steam-power. The outfit comprised three iron-handled windlasses and buckets (22 gallons), railroad, coal and poli-picks, round and straight-edged shovels, saws, axes, a churn drill (borrowed), wheelbarrows and a few small tools. Mr. R. F. Shirley acted as foreman and superintended the work in an energetic and satisfactory manner.

In cleaning out some of the old openings some trouble was experienced with water standing in the old workings, but this difficulty was successfully overcome. In some places we also were troubled with large quantities of water met in sinking through the alluvium and drift covering the outcrop of the coal. This water was found in beds of gravel and loose quicksand, and in one or two instances was so strong that we were unable to manage it by hand and were forced to choose new locations for the openings.

Prospecting Methods.—When it was considered advisable to open the coal where the position of the outcrop could not be exactly determined, the search was prosecuted by a series of pits and bore-holes as shown by the accompanying sketch,—Fig. 1.

SKETCH SHOWING METHOD OF PROSPECTING.

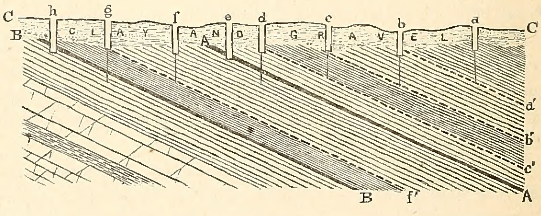

Fig. 1.

The pits were sunk through the surface drift and into the slates until they became too hard for rapid sinking, and a bore-hole was then drilled to a further depth of fifteen to thirty feet. The pits being commonly ten to twenty feet deep, the combined depth of pits and bore-holes was from twenty-five to forty feet. The pit and bore-hole *a* (Fig. 1) would show the presence or absence of any coal bed down to the stratum *a′*; the shaft and bore-hole *b* would prove the rocks lying between the stratum *a′* and *b′*, etc., etc.; the coal AA struck in bore-hole *d* would be opened for examination by the shaft *e*, and so on. Thus the whole series of rocks between C and C would be thoroughly explored by this series of shallow shafts and bore-holes. In the sketch above, AA and BB represent beds of coal, CC is the surface; the lines *a′*, *b′*, *c′*, *f′* are merely introduced to show the strata explored by each shaft and bore-hole.

The six bore-holes and shafts averaging say 30 feet in depth, 15 feet of which is in the bore-holes, explore the same thickness of rock that would be proven by a single bore-hole 90 feet deep, but the shallow holes are cheaper and the results more satisfactory. The cost of these six bore-holes may be estimated as follows:

Cost of six bore-holes.

6 shafts average depth 15 feet at 20 cents per foot	$18 00
6 bore-holes average depth 15 feet at 25 cents per foot	22 50
Total	$40 50

Cost of one deep bore-hole.

1 shaft 15 feet deep at 20 cents per foot	$ 3 00
Erecting spring-pole drilling rig	7 00
Boring 90 feet at 60 cents per foot	54 00
Total	$64 00

The single deep bore-hole would then in this case cost 58 *per cent.* more than six shallow bore-holes, and the results obtained from it would not be as satisfactory as those given by the shallow holes. Hence, in exploring for coal in areas in which the rocks all dip in one direction and at a considerable angle, I believe the sinking of shallow pits and bore-holes will give cheaper and better knowledge of the rocks than any other plan.

Those not practically familiar with coal deposits elsewhere may object to this method on the ground that while the presence or absence of coal may thus be proven, it yields no positive information as to the condition of the coal at considerable depth beneath the surface. As this topic will be discussed in chapter IV, it is only necessary to state here that if a coal bed is regular and persistent for a long distance,—several miles,—at its outcrop there can be no reasonable doubt of its extension in similar condition to considerable depth beneath the surface.

After striking and opening the coal at sufficient depth to get good, firm, black coal,—in other words, below the water-line or below the partly disintegrated and decomposed outcrop coal,—a sufficient quantity was mined to show the quality of the coal and its behavior in the fire, and to insure the selection of true average samples for analysis. The analyses were made in the chemical laboratory of the North Carolina Agricultural Experiment Station, under the direction of Dr. Chas. W. Dabney, Jr.

CHAPTER II.

THE MESOZOIC AS A CARBONIFEROUS FORMATION.

The coals of the Deep River and Dan River districts in North Carolina, and of the "Richmond basin" (Chesterfield) and Farmville deposits of Virginia, occur in what is commonly known as the Mesozoic, Triassic or New Red Sandstone ("New Red") formation.

This formation exists in several other States but is known to contain beds of coal only in North Carolina and Virginia. Hence we do not seem justified in designating it as a coal-bearing formation in this country.

In European countries the formation is well represented, but after long search, I am unable to find any reference to the occurrence of coal in it. Naumann's great German work describes the formation minutely but no mention is made of coal. Nor does it appear that coal has been found in rocks of this age in Africa, China or Japan, but as our geological knowledge of China and Africa is quite defective, such deposits may exist, although at present unknown.

In Asiatic countries also coal of this age is unknown except in India, where it is found in what is known as the Damoodah and Talchir districts.

As this is the only other known occurrence of coal in rocks supposed to be of the same age as the North Carolina series, a short description of this Damoodah coalfield is in place here as directly bearing upon the subjects discussed in this report.

The same difficulty has been experienced by the Geological Survey of India in determining the age of the Damoodah deposits that Prof. Emmons encountered in the North Carolina series. In the Talchir and Damoodah fields the rocks are divisible into three groups, very similar to their division in this State, the middle member being coal-bearing. The palæontological evidence in both fields would seem to indicate that the true age of the series is intermediate between the Permian and Triassic, this being the opinion cautiously expressed by Mr. W. T. Blanford, of the India Survey, and Prof. Emmons was inclined to consider the North Carolina series in part of Permian age.

However this may be, as we have no means of correlating the series in the Atlantic Coast States with the Permian of the anthracite (?) and bituminous coalfields of Pennsylvania and West Virginia, it seems best to avoid confusion by accepting the name by which the formation is now most generally known,—Triassic.

The Indian coalfields present many features most strikingly similar to those of the North Carolina and Virginia coalfields, the Damoodah district resembling closely the Virginia field and the Talchir district the Deep River coalfield of this State.

In India the formation is also characterized, as in this country, by large areas destitute of coal or in which the coal is represented by beds of slate and coal so mixed as to be worthless, or by beds of carbonaceous, bituminous or graphitic shale or slate. Trapdykes are a prominent feature in both countries. Full descriptions of these Indian coalfields may be found in the Memoirs and Reports of the Geological Survey of India.

The coal of the Damoodah district is of great commercial importance, but this is owing to its distance from other coalfields and is not due to the quality of the coal, which appears to be quite poor as shown by the following analysis which represents the average composition shown by the analyses of thirty-one samples.*

Damoodah (India) Coal.

Carbon,	66.20
Hydrogen,	4.64
Oxygen and nitrogen,	11.30
Sulphur,	0.85
Ash,	17.01
	100.00

In recent years mining has been prosecuted with vigor in this Indian coalfield, and some very fair coal is now mined and shipped. The heating power of these coals is much lessened by the presence of more than four *per cent.* of water,—an objection that does not apply to the North Carolina coals.

The palæontological evidence in hand would seem to indicate that the Australian coalfields are, in part at least, of the same age with the Damoodah rocks, but they are not so classed, and it will not be safe to infer that this assumption is correct.

It then appears that the only other coals known in rocks of this age are found in India, and that the formation is coal-bearing in no other localities. From this we may conclude that during the period in which these rocks were being deposited, there were no general and widespread conditions favorable to the growth of coal-producing vegetation and to the accumulation and preservation of the carbonaceous matter, but that such conditions did exist over isolated areas of limited extent.

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*Records of Geological Survey of India, Vol. XV, Part I. 1882.

East of the Mississippi.—In that portion of the United States lying east of the Mississippi River the Triassic, or "New Red Sandstone" formation occurs only in the States bordering upon the Atlantic Ocean between Maine and Georgia, and is confined to the area east of the Blue Ridge, North, or Blue Mountains.

In Massachusetts and Connecticut it occurs in the Connecticut Valley. New York contains a small area of it near New York City, from which it sweeps across New Jersey, Pennsylvania and Maryland, into Virginia, where it is found in many detached patches, one of which, the "Dan River belt," passes into North Carolina some thirty miles or more. The other belt found in North Carolina extends some distance into South Carolina.

In the States north of Virginia the formation consists almost entirely of shale and sandstone, with a predominating and characteristic red, or brownish-red, color. The brown sandstone, so much esteemed as a building stone in New York City, is quarried from this formation in the Connecticut Valley.

In these States north of Virginia the middle group of blue coal-bearing States is not well developed, and is perhaps generally entirely absent.

In North Carolina.—Two belts of the formation are shown by the map, the outlines of which are taken from Prof. Kerr's geological map of the State. The section accompanying the map shows how the formation lies in depressions in the older metamorphic rocks, with the Dan River series dipping north-west and those of the Deep River dipping south-east, as if these two isolated belts were the remnants of a great anticlinal arch formed by an uplift of the older formations that now form the intermediate country. It will be unnecessary to describe in detail the limits of the formation and the course of these two belts, as all this is plainly seen by reference to the map, (Plate II).

Thickness.—The formation is probably many thousand feet thick, but as no exact measurements have been made, it is not possible to make an estimate that can be considered as even approximately correct. If we calculate the apparent thickness by multiplying the sine of the average angle of dip by the breadth of the outcrop, the result seems almost incredible, for in some localities the formation is fifteen or twenty miles wide and the dip, in one direction, varying from ten to forty degrees in strength, thus indicating a thickness of 25,000 to 30,000 feet. As, for many reasons, both geological and topographical, such a great thickness seems quite improbable, two theories have been advanced to explain the monoclinal dip over so wide an outcrop without conceding the existence of a great thickness of rock. One of these supposes the existence of a number of faults by which the same series is repeatedly brought to the surface. This seems plausible, and a comparatively thin series might thus appear quite thick, but the existence of these faults has not been proven, and until this is done it seems unsafe to accept this hypothesis. The apparent existence of a great anticlinal arch in North Carolina, and of basins in Virginia, throws much doubt over the probability of this theory proving true.

The second theory supposes the rocks were deposited inclined in nearly the same position in which they are now found, but the existence of beds of coal and black-band apparently conformable to the series, is strong evidence against the truth of this hypothesis.

We can, therefore, at present only assume that the formation is probably of great thickness in this as well as in the other States in which it exists, but the facts in hand are sufficient to prove that this thickness is by no means constant but is subject to great variations which may often occur in comparatively short distances.

In parts of Virginia, in North and probably in South Carolina, the formation is divided into an upper and lower series by the addition of a middle member composed of dark slates and grey sandstones carrying beds of coal, black-band, fire-clay, layers and balls of carbonate of iron, impure limestone, and beds of highly bituminous or carbonaceous slate and shale. In the Northern States this middle member has not been recognized.

Age.—The age or era to which these three subdivisions and the whole formation should be referred has not been conclusively settled, but in the absence of absolute knowledge geologists generally speak of the formation as Mesozoic, and it is often more specifically designated Triassic.

Prof. Emmons evidently rather leaned to a belief that the lower member should be considered of Permian age, and the middle and upper members Triassic or Liassic.

Admiral Wilkes described the upper member as Tertiary, and the middle member he called simply "coal measures."

It would now seem that these views should be abandoned and that the whole series should be classed as Mesozoic and perhaps as Triassic, not so much because this correlation will ever be demonstrated as exactly right, as because nothing is to be gained by perpetuating a controversy when there are no means apparent by which it can ever be finally settled.

Occurrence of Coal.—The occurrence of coal in the Mesozoic New Red Sandstone formation in the United States in beds exceeding a few inches in thickness is limited to Virginia and North Carolina. Thin seams, two or three inches thick and of limited extent, and small isolated masses constituting the carbonized remains of single tree trunks, have been found in Pennsylvania, New Jersey, and Connecticut, but these occurrences are evidently purely accidental, for the associated rocks do not indicate the presence of conditions favorable to the formation of coal.

In the former States, however, the coal occurs in beds showing some degree of regularity and is accompanied by a series of slates and shales with beds of fire-clay and carbonate of iron, very similar to the rocks associated with coal of the Carboniferous period. From this similarity we naturally infer the existence of somewhat similar conditions at the time of deposition, and this inference would lead us to pre-suppose the existence of coals exhibiting in some degree a regularity approaching that of the true coal measure coals. These are the conclusions the geologist necessarily adopts in the absence of any contradictory facts. They evidently express the position taken by Prof. Emmons (in North Carolina) and by Mr. Oswald J. Heinrich* (in Virginia).

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* "The Mesozoic Formation in Virginia." By O. J. Heinrich, in Transactions of the American Institute of Mining Engineers, February, 1878. Vol. VI, pp. 227 to 275.

These views seem also to have been held by Prof. Kerr, for on page 295 (Geol. of North Carolina, 1875) we find: "An exploration of the whole length of both these coal areas" advocated to ascertain "accurately the depth, thickness and all the conditions which will determine their value," and in conclusion, "I do not think a few thousand dollars could be more profitably expended."

Such an exploration has now been made, and its results have been both negative and positive: Negative, in that facts have been obtained showing that large areas supposed by Prof. Emmons, Admiral Wilkes and other writers to contain valuable coal, are comparatively worthless in a commercial sense; positive, in that the area containing good coal has been approximately defined.

As in arriving at general conclusions respecting not only the value of the coal and its extent, but also those bearing upon the possible difficulties that may be encountered in mining, those affecting the regularity of the beds and their peculiarities as contrasted with other coals, we may be greatly aided by the analogy between the Deep River coals and its rock series and those of the Virginia coalfields, extracts are here given from the above quoted paper by Mr. O. J. Heinrich.

Virginia Coalfields.—Coal has been worked in what is known as the "Richmond basin," lying south and west from Richmond and distant from that city some eleven miles or more, and in the "Farmville district" in Cumberland and Prince Edward counties. The latter district is of small importance, the beds being thin and poor.

The following is a condensed description of the formation at the old Midlothian Colliery, in the Richmond basin:

	FEET.
7. Upper sandstone group. Thickness possibly,	2,000
6. Upper calciferous group—principally light gray sandstones, often calcareous, with dark gray and black slates. Thickness,	334
5. Oleiferous group—sandstones, light gray and white, sometimes calcareous (three bands being oleaginous), with black and greenish gray slates with thin seams of impure limestone. Thickness,	191
4. Carbonaceous group—sandstones, light colored and dark, even black; dark drab and black slates, with coal beds. Thickness,	150
3. Lower calciferous group—light and gray sandstones, largely calcareous, with dark gray, black and bituminous slates, ash-colored shales and fire-clay, with a few thin beds of impure limestone. Thickness,	245

2. Lower sandstone group—sandstones grayish and reddish-gray, sometimes brownish, with some slates black and brownish black. Thickness,........ 251
1. Boulder formation—hard and soft ferruginous reddish sandstones, with quartz and granite boulders near bottom. Thickness,........ 36

Two workable beds of coal are found in group No. IV, one of which, the upper, reaches a thickness of 20 to 40 feet divided into two benches by 5 to 10 feet of slate. The lowest bed is 3 to 5 feet thick. These thicknesses are not constant, the beds being subject to marked variations in size and character. The coal is "highly laminated, bright black jet, highly resinous, thick laminæ, generally in thick layers alternating with dull black laminæ of less dimensions," fracture conchoidal, splits parallel to stratification, weight of one cubic yard 2,075 lbs. "It contains on an average 30 to 38.5 per cent. of volatile matter; 59 to 66 per cent. of fixed carbon; 2 to 10.8 (average 21 analyses 5.58) per cent. of ash, and 0.6 to 1.7 per cent. of sulphur."

Carbonite (natural coke) and semi-anthracite are also found as in North Carolina.

From over forty analyses given by Mr. Heinrich, I select the following to show the character of the Richmond basin coal. Most of these analyses show better coal, but no reference is made to the character of the samples from which the analyses were made except those given below:

	Midlothian Colliery.				*Carbon Hill*
	Average.*	Screened.*	Average.†	Screened.†	Average.*
Moisture	2.455	1.785	1.050	1.03	1.785
Volatile Matter...	29.738	34.295	36.490	38.23	23.959
Fixed Carbon.......	53.012	54.063	46.702	54.27	59.976
Sulphur...........	.058	.202	2.230	1.52	——
Ash..............	14.737	9.655	15.758	6.47	14.280

* Made by Prof. Johnson. † Made by A. S. McCreath.

The principal difficulties encountered in mining and developing this Richmond coalfield are the irregularities to which the beds are subject, the occurrence of mine fires from what is supposed to be spontaneous combustion, and the presence of firedamp in large quantities in the deeper workings.

The Mesozoic on Deep River.—Here, as also in the Dan River field, the rocks are naturally divisible into three groups, thus:

Upper Red Sandstones and shales.

Coal slates,—blue and black shales and slates with fire-clay, black-band and coal.

Lower Red Sandstones and shales, with conglomerate beds at or near the base.

Upper Red Sandstones.—This is probably the equivalent of No. VII of the Virginia series. Its thickness has not been measured in North Carolina, but it is known to be at least several hundred if not many thousand feet thick.

Coal Slates.—This middle member consists of dark carbonaceous and bituminous shales and slates with some beds of gray sandstone, and a few layers of impure limestone. In intimate association with the coal are beds of fireclay, black-band and carbonate of iron.

This member is naturally divisible into sub-groups corresponding to the Virginia groups VI, V, IV, and III (see description of rocks passed through by the shaft at Egypt), thus:

Virginia.	*North Carolina* (*Deep River*).
VI. Upper Calciferous group=	300′ + calcareous slates and shales in Egypt shaft.
V. Oleiferous group (191′)=	125′ + oleaginous and bituminous shales and slates.
IV. Carbonaceous group (150′)=	60′ + slates and shales containing 5 coal beds.
III. Lower Calciferous group (245′)=	slates, sandstones and shales below the coal.

This middle member thins out and almost entirely disappears to the north-east from the Deep River district; to the south-west it apparently maintains its thickness for a considerable distance. Even within the limits of the coal development it varies remarkably in thickness.

Lower Red Sandstone and Conglomerate.—This is doubtless the equivalent of Nos. II and I of the Virginia series. It directly underlies the dark slates of the middle member and rests upon the metamorphic slates and schists of the Huronian (?) age. It varies greatly in thickness. On Deep River it is apparently from 500 to 1,500 feet thick. The conglomerate found at its base, and from which corn-mills are now being made, is not always present.

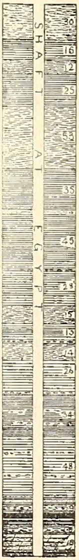
This correlation of the North Carolina and Virginia series apparently establishes their actual equivalence, and as it is also supported by palæontological evidence, we may consider the identification certain,—hence the importance of studying each district with reference to its bearing upon undetermined problems presented by the other.

As this examination deals principally with the middle member of the formation,—the *Coal slates*, corresponding with Nos. VI, V, IV and III of the Virginia series,—the only portion that can be considered as coal bearing and more particularly with the sixty feet of measures immediately associated with the coal, the following section of these rocks as found at Egypt shaft is here reproduced from Admiral Wilkes's report of 1858, to show the character of these measures.

Wilkes's Section Egypt Shaft.

Soil		Calcareous group.	30′
Black slate			16′
Calcareous shales			12′
Black slates			25′
Green calcareous shales			53′
Black bituminous slates			35′
Calcareous shales			4′
Black bituminous slates			45′
Iron balls			1′ 10″
Black slates			28′
Calcareous shales			15′
Hard black slate			13′
Black slates,—iron balls			3′ 8″
Sparry calcareous green shales			14′
Black slates		Bituminous group.	26′
Iron balls			2′ 2″
Sandstone			1′
Black slate, fireclay, iron balls			34′
Black slate, argillaceous iron beds and balls			48′
Sandstone			1′ 10″
Black slate,—iron balls			1′ 4″
Sandstone			3′
Black slate,—iron balls			9′
Coal	"Upper bed"	Carbonaceous group.	4′
Black-band			1′ 4″
Coal			1′ 1″
Slate			0′ 6″
Coal			0′ 7″
Black bituminous slate,—iron balls			8′
Gray sandstone and fireclay			16′
Black-band			1′ 5″
Coal			1′
Black-band			3′
Total depth given as			460′

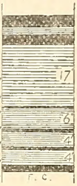
Fig 2



The following section of the carboniferous group at Farmville (N. C.) shows the character of this sub-group in closer detail and its remarkable resemblance to the coal group at Midlothian colliery in the Richmond basin as given by Mr. Heinrich.

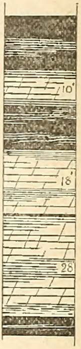
Farmville, N. C.	
Upper Coal: Coal, 3′ Slate, 2′ Coal & Slate, 3′	8′
Slate & sandy fireclay,	17′
Coal,	0′ 4″
Slate and fireclay	6′ 0″
Coal,	1′ 0″
Slate and fireclay,	4′ 0″
Coal,	1′ 2″
Slate and fireclay,	4′ 0″
Lower coal,	2′ 0″

Fig. 3



Midlothian Colliery, Va.	
Upper coal—slate parting	14′ 6″
Slate and gray sandstone	10′
Coal—slate partings	12′
Slate and gray sandstone	18′
Coal	1′
Slate and gray sandstone	28′
Lower coal 1½′ slope,	5′

Fig. 4



Only the upper and lower beds seem to be persistent for any distance in both fields. The intermediate beds are sometimes represented by only one thin seam or are entirely absent. Three intermediate beds have been found in some parts of the Virginia coalfield; the Midlothian section above showing one less, and hence not in entire agreement with the Farmville section.

History of commercial development.—Mr. Heinrich states that coal was discovered in the Richmond basin as early as 1700, as in that year it was used in the neighborhood. Systematic mining for shipment was commenced about 1790, this being the first coal mined for shipment in the United States. Notwithstanding the advantage secured by its early development and its proximity to the seaboard, the output of coal from this basin has grown very slowly in comparison with other mining fields opened at a later date. Mr. Heinrich places the total output from 1822 to 1842 at 1,925,000 tons, an average of 96,250 tons per annum or 320 tons per day. In 1843 the output was 95,606 tons; in 1850 it had reached 138,017 tons; in 1861 it fell to 94,697 tons; in 1869 reached 115,564 tons, and has since declined greatly; only 57,182 tons being produced in 1876, and 67,907 tons in 1877, which would only be considered a fair output for a single colliery of moderate size in any other mining district. This coalfield is only 13 to 24 miles by railroad from tide-water navigation. No other competing bituminous coalfield is much less than two hundred miles from tide-water navigation, and this difference of about two hundred miles has in the past made an average margin of not less than $2.00 per ton in favor of the Richmond field, yet its development has been remarkably slow—so slow that even in the absence of actual knowledge, the existence of some peculiarly unfavorable conditions could be safely assumed. Mr. Heinrich estimates the total production of the field from 1822 to 1878 at 5,647,621 tons.

The existence of coal in the Deep and Dan river districts was known at a very early day. As the coal and bituminous slates are often exposed at the surface, its discovery must have been made shortly after the country was settled. Coal was dug from open pits for blacksmithing in the Deep River field early in this, if not indeed in the last century, but no systematic attempt was made to open the field to market until the slack water improvement of the Deep River. As these improvements were seriously damaged by floods soon after the completion, the people were discouraged from further attempts at that time. The next attempts were made upon the completion of the railroad from Fayetteville to Egypt and the Gulf. Some coal was shipped over this road from the shaft at Egypt, but the cost of transportation to Fayetteville and of trans-shipment and towing down the Cape Fear River to Wilmington, (somewhat over a hundred miles, I believe), on a river full of shoals, was doubtless too great to leave any profit. Operations were most actively pushed in the period immediately preceding the war. During the war coal was mined at Farmville, Egypt, Gulf and the Evans' place, and shipped by river to Fayetteville and to Wilmington, where it was used to some extent by blockade-runners, but the aggregate amount thus shipped must have been quite small.

After the war some coal was mined at Farmville, Egypt and Gulf, but only a small quantity was shipped to a distance. Excluding the quantity mined from the shaft at Egypt, of which I have no means of judging, I believe the total quantity of coal mined in this Deep River district down to the present time, does not exceed 25,000 tons, if, indeed, it amounts to half so much.

In the Dan River district the only mining that has been done is near Leaksville, where coal was mined during the war for use in the shops at Danville. The quantity shipped was quite small.

Useful Minerals.—As this exploration was for coal only, no special examination was made of the other useful deposits accompanying this series of rocks. The following notes summarize the results of such cursory examinations as were made:

Black-band.—Much has been written of the black-band iron ore that accompanies the coal and that is also found inter-bedded with the bituminous slates of the carbonaceous group, but as it is so loaded with phosphorus as to be at present worthless, it is questionable whether it should be called an "iron ore" at all. It ranges low in iron and high in volatile hydrocarbons and fixed carbon, and often contains a notable percentage of lime. The roasted ore may contain from 20 to 45 per cent. of metallic iron. The phosphorus is due to the presence of fish and other organic remains. I have seen analyses showing as high as 12 per cent. of phosphoric acid, but while this is phenomenally high, the amount of phosphorus is doubtless always too large to permit its use in iron making. At some future date it may possibly come into use in the manufacture of steel by the "basic" or some other process.

Carbonate of Iron.—The beds of carbonate of iron that are found in the "coal slates" are apparently local deposits of moderate thickness. They are commonly altered into hematites at their outcrop. It does not seem probable that they will prove to be of any immediate value.

Limestone.—Beds of impure limestone occur in the slates above the coal, but as yet no beds have been found sufficiently pure for building or for use as a flux.

Millstones.—In Moore county the conglomerate at the base of the formation yields an excellent stone for corn-mills. A factory has recently been established by the "North Carolina Millstone Company," and complete mills ready for the belt are now made and shipped in large numbers. They are in use in many parts of the United States, and have already won an enviable reputation.

Grindstones.—Some of the gray sandstones seem well adapted to this use, but in the absence of definite knowledge as to the behavior of the stones in use, I must refrain from expressing any decided opinion of their quality. I understand they were so used many years since when stones brought from other States commanded a high price.

Fireclays.—No investigation has been made of the quality of the beds of fireclay accompanying the coal beds. Their quantity is practically inexhaustible, and if upon trial they are found of good quality, there is no reason why this and the adjoining States should not be supplied with fire-brick from this district. Judging from the appearance of these clays alone, I am inclined to think them rather poor and certainly variable in quality, but as the appearance of such clays is often deceptive, this opinion should be taken only for what it is worth,—a mere expression of an impression, perhaps totally erroneous.

CHAPTER III.

EXPLORATIONS IN THE DEEP RIVER COALFIELD.

It will be unnecessary to describe in detail the course of the outcrop of the coal-bearing group, as this is plainly shown by the map, Plate 3, the general outlines of which were taken from Capt. Wilkes's map, (35th Congress, 2d session, Senate Executive Document No. 26). It shows the relative locations of the principal plantations and appears to be reasonably accurate. Had the prospects been more favorable I would have advocated the making of a complete instrumental survey of this coalfield, showing all the minor geographical and topographical details, but under the existing circumstances I did not feel warranted in urging the expenditure of time and money for this purpose.

Explorations were commenced at Farmville, which seems to be the practical (commercial) eastern limit of the coal. Coal has been found at the McIver place, and is reported on the Dye and Wicker plantations, still further east; but from all accounts the prospect in this direction seems so unfavorable that I did not feel justified in pushing the examinations east (rather south or southeast) of Farmville.

The localities at which explorations were made are described below in the following order, but this is not the order in which the explorations were made:

1. Farmville,
2. Egypt Shaft,
3. Taylor Place,
4. Gulf,
5. Evans' Place,
6. Gardner Place,
7. Murchison Place,
8. Fooshee Place.

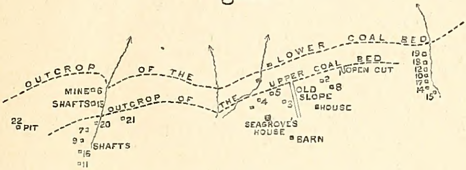
I.—FARMVILLE.

As it was deemed necessary at the very outset to gain as thorough knowledge as possible of the character and associations of the coal beds and the rocks enclosing them, the examinations here made were prosecuted with closer attention to these details than was considered necessary elsewhere. At other points the exploration ceased when the coal had been opened so as to expose its whole thickness and a sufficient quantity taken out to accurately determine its quality. Here, however, it was considered necessary to carry the explorations far enough to show the variations in thickness and quality to which these coals were subject, and to ascertain the causes and character and importance of such irregularities.

Coal Mined for Raleigh.—The first openings having disclosed the presence of the lower bed (Fig. 5, Pit No. 6) of workable thickness,—20 to 24 inches of good coal,—and quality, I was authorized by the Board of Agriculture to mine sufficient coal to supply the Raleigh State Exposition. This prolonged our stay at Farmville some three or four weeks, and enabled us to add materially to the explorations already made. About one hundred and sixty-five tons were mined, of which about one hundred and five tons was shipped to Raleigh.

This coal was mined and raised by hand from a shaft (Fig. 5, Pit No. 13) twenty-eight feet deep; the water was also raised by hand on the same windlass (about 2,000 gallons per day); ventilation was maintained through board pipes ten inches square by a large kerosene lamp placed in the pipe at the bottom of the shaft. The shaft was 5 feet wide by 8 feet long and the coal when opened had a (local) dip of from 5 to 10 degrees.

Fig. 5.



EXPLORATIONS AT FARMVILLE.

The total cost of mining, superintendence not included, was

For labor	$1.18	per ton.
Supplies and incidentals	27	"
Total	$1.45	"

In use, the coal proved a strong and satisfactory steaming coal, but some objection was made to it on account of its rather large percentage of sulphur. Its quality will be discussed below.

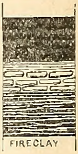
A considerable quantity of coal has been taken out on this Farmville property. A slope was sunk on the "main" or upper bed (see Fig. 5) before the war, and works were erected for the manufacture of illuminating oil from the bituminous slates overlying the coal. Some of the machinery may still be seen in place, but most of it was removed during the war. The hoisting machinery and boilers are still in place, but completely ruined by exposure.

The old slope is reported as from 160 to 260 feet deep. On the east side of the slope the coal was worked only a short distance and a "pinch" encountered; on the west side the coal has been developed for a distance of perhaps 200 feet and nearly every ton lying above water-level has been taken out. The ground has been completely "hogged over" by stripping the coal. Some coal below water-level has also been mined both before and since the war from two old shafts about 40 feet deep, but the quantity taken out was quite small.

This coal was opened by a shallow pit at a point indicated by Mr. Seagrove (Fig. 5, Pit No. 4), where the stump of a pillar had been left untouched, and the bed was found at a depth of eight or ten feet. The coal was bright, black and in good condition and measured almost exactly three feet in thickness. A second shaft (Fig. 5, Pit No. 5) was sunk within a few feet of this one, to and through the black-band and lower bench of this coal bed; thus a full measurement of the bed was made which gave:

Slate roof,	
Coal, good,	3′ 0″
Graphitic fissile slate,	2″
Slate and Black-band,	2′ 0″
Slaty coal and Slate mixed,	3′ 0″
Fireclay floor,	
Slate,	

Fig.6



Attempts made to find this coal west from these old workings were for a time unsuccessful, but were finally rewarded by finding it at two points about 150 feet apart and about 600 to 800 feet west from the old slope, but the bed was in a sadly attenuated form, for at the point farthest west (Fig. 5, Pit No. 20) the coal measures only about twelve inches, and at the other pit (No. 21) the bed is less than eighteen inches thick, and at both places its quality is very poor, as shown by analyses Nos. 13 and 14.

About 400 feet east from the slope (Pit No. 1), the coal has been found of normal thickness and some coal has been taken out, but the bed was found to change abruptly to "carbonite" (natural coke) in one direction (west) and to "pinch down" to small size to the south-east. I sunk two shafts between this point and the old slope, and in one of them (Pit No. 2) found only about ten inches of coal, and it had the appearance of having been burnt; in the other shaft (Pit No. 8), the coal measured scarcely more than one foot, and is shown by analysis No. 15 to be of wretched quality, although from the appearance of the coal it would not be supposed to contain nearly so much sulphur and ash, but as the sample was carefully averaged from about one ton of coal the analysis doubtless shows the true character of the bed at this point.

A series of pits and bore-holes were sunk in search of this bed about 400 feet further east. These pits were located along the edge of a gully in which black slate and carbonaceous smut were plainly visible. (See Fig. 5, Pits Nos. 10, 12, 14, 15, 17, 18, 19). They failed to show the existence of coal, but as the peculiar fissile graphitic slate or shale that accompanies the coal was found, the absence of the bed at this point seems well established. The pits were from eight to twenty feet deep, and from the bottom of each a bore-hole was carried to a further depth of from fifteen to thirty feet, making the depth of pits and bore-holes combined from thirty to forty feet.

The explorations on this bed, therefore, indicate the existence of a body of workable coal of quite limited lateral extent, so far as is at present known, and establish the fact that the bed is subject to abrupt changes from a workable seam of good coal to a thin bed of impure coal.

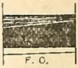
About thirty feet below this upper or "big" bed there is another seam that has already been referred to as the "lower" or "two-foot" bed, and between these two beds I have found three other small seams, but as these are all too thin to be of any importance they will not be described in detail here.

The lower, or "two-foot" bed is the one from which the coal for the Raleigh State Exposition was mined. It had been worked in the past, in a small way, at a number of points on this property, where Mr. Seagrove states that it was commonly found to carry from eighteen to twenty inches of workable coal.

At the mine shafts, (Fig. 5, Pits Nos. 6 and 13), the bed was thicker and apparently of better quality than at these old workings. The bed here measured:

Fireclay and clay slate roof	
Slaty coal,	8″ to 4″
Coal—good,	1′ 8″ to 2′ 0″
Slate in cubical blocks,	3″ to 5″
Fireclay floor,	

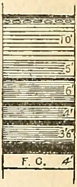
Fig. 7



A section of the measures lying between this bed and the upper, or "big" bed, as exposed by these shafts, is as follows:

Clay slate roof	
Coal; big, or upper bed (here only),	1′ 0″
Slate and black-band,	1′ 6″
Fireclay and slate (estimated),	10′ 0″
Slate,	5′ 0″
Coal,	0′ 4″
Slate and fireclay,	6′ 0″
Coal,	1′ 0″
Slate and fireclay,	4′ 0″
Coal,	1′ 2″
Slate and fireclay,	3′ 6″
Slaty coal,	0′ 8″
Coal,	2′ 0″
Slate (in blocks),	4″
Fireclay,	4′ 0″

Fig. 8



Twenty-two shafts were sunk on this Farmville property. Their location is shown by the sketch map, Fig. 5, which, in connection with the following descriptions, will enable any one to understand the method of exploration adopted in examining this property:

Pit No. 1.—Open cut ten feet deep on natural coke. Good coal was mined only ten feet south from where the coke is exposed.

Pit No. 2.—Shaft eighteen feet deep to "Big" bed, here less than one foot thick.

Pit No. 8.—Shaft twenty-six feet deep to "Big" bed, here about one foot thick. This pit passed through

Surface clay and gravel,	16′
Slate,	6′
Coal, (See analysis No. 15),	1′
Slate and coal mixed,	1′ 6″
Fireclay, hard,	1′ 6″
“ in bore-hole,	4′ 0″

Pit No. 3.—This broke into old workings on the “Big” bed.

Pit No. 4.—Shaft to open “Big” bed, (upper bench), passing through

Surface clay,	4′
Fireclay (decomposed slate ?),	2′
Coal, good (analyses 8, 9, 10),	3′

Pit No 5.—To open lower bench of “Big” bed, showing,

Surface clay	5′
Coal (upper bench wanting, having been mined out by stripping).	
Black-band and slate,	2′
Slate and coal mixed, crushed and shelly,	3′
Fireclay	

Pit No. 21.—Shallow opening on “Big” bed, which is here only about 1′ 6″ thick,—see Analysis No. 14.

Pit No. 20.—Shaft 15 feet deep through surface drift and slate to “Big” bed, here only about one foot thick,—see Analysis No. 13.

Pits Nos. 7, 9, 11, 16, were sunk in search of the “Big” bed before striking it at No. 20.

Pit No. 7 passed through

Surface clay,	6′	
Gravel (water strong),	2′	
White clay,	4′	
Fireclay,	5′	15′
“ in bore-hole,	10′	

Pit No. 11 passed through surface clay and gravel 15 feet to a bed of quicksand carrying an immense quantity of water.

If this pit had been sunk 3 feet deeper it would have struck the “Big” bed, but the bore-hole caved in and the water became unmanageable. The same difficulty with the water was encountered in No. 9, which was sunk only 15 feet.

Pit No. 16.—Shaft and bore-hole 20 feet deep, which passed through:

Surface clay,	5 ′
Gravel and sand (water),	3½′
Fireclay (bore-hole),	4 ′
Black slate (bore-hole),	1 ′
Fireclay slate (bore-hole),	9 ′

Pits Nos. 6, 13.—These shafts were respectively 18 and 28 feet deep. 60 tons of coal was mined from the first and 105 tons from the second. They are on the lower bed.

Pit No. 22.—Shallow shaft to test the nature of the ground, which was found loaded with water at a depth of only 4 feet. This is on a high flat piece of ground.

Pits Nos. 10, 12, 14, 15, 17, 18, 19.—These were sunk in search of the "Big" bed. Nos. 14, 15, 17, did not reach the horizon of the coal, being in the overlying fireclay and slate measures.

Pit No. 10, passed through:

Surface clay,	6 ′
Sand and gravel,	8 ′
Fireclay,	3½′
Fireclay (bore-hole),	16 ′
Black graphitic slate,	2 ′

This black carbonaceous slate was exposed by natural outcrop in the adjoining pits.

Pits Nos. 12, 18, passed through:

Surface clay,	8′
Gravel,	4′
Blue black slate,	3′
Slate, slick streaked with coal, somewhat graphitic,	5′

This is evidently the only representative of the "Big" bed present at this locality, the coal itself being almost entirely absent.

The following analyses showing the character of the Farmville coals were made under the direction of Dr. Dabney (by Mr. Battle, I believe,) at the Agricultural Department chemical laboratory.

A larger number of samples were taken for analysis at Farmville than at other points, because it seemed desirable to obtain an insight into the composition of these coals during the earlier stages of the exploration:

Analyses of Farmville coal,—Lower bed.

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.
Water at 115°C......	1.71	0.75	2.15	1.36	1.32	......	.....
Volatile matter......	28.66	88.15	28.88	28.71	26.87	30.91	30.85
Fixed carbon.........	60.59		52.56	51.24	50.04	50.70	63.90
Sulphur.................	3.69	4.01	3.72	4.18	7.08	......	......
Ash......................	5.35	7.09	12.69	14.51	14.69	18.32	5.25
	100.00	100.00	100.00	100.00	100.00	99.93	100.00
Weight of cubic yard lbs....................	2,287	......	2,286	2,253	2,248	......	......

No. 1.—Sample of lump coal from shaft 14 feet deep (Pit No. 6).

No. 2.—Analysis made from same sample as No. 1.

No. 3.—Average sample taken from the same shaft, from 60 tons of coal.

No. 4.—Slack coal mined at depth of 24 feet (Pit No. 13), average sample from large pile.

No. 5.—Picked lump coal (best) from the pile from which No. 4 was taken.

No. 6.—By Prof. Johnson.—This analysis is taken from Emmons' Report of 1856.

No. 7.—By Prof. Johnson.—This analysis is taken from Emmons' Report of 1856.

Averaging the first four analyses for sulphur we obtain 3.90 *per cent.*

Averaging all seven analyses we find the average ash equal to 11.13 *per cent.*

Analyses of Farmville coal,—Upper or "Big" bed.

	No. 8.	No. 9.	No. 10.	No. 11.	No. 12.
Water at 115° C............	1.79	0.40	1.95	1.71	2.35
Volatile matter.............	29.56	89.13	30.54	(81.39)	(93.62)
Fixed carbon...............	58.30		58.47		
Sulphur.......................	2.89	3.11	2.19	3.30	0.22
Ash..............., ...	7.46	7.36	6.85	13.60	3.81
	100.00	100.00	100.00	100.00	100.00
Weight of cubic yard, lbs.	2,231	......	2,200	......	......

No. 8.—Taken at depth of ten feet, coal bright and black. (Pit No. 4).

No. 9.—Analysis made from same sample as No. 8.

No. 10.—Average sample from two tons taken from same place.

No. 11.—Taken from Emmons' report of 1856; made by Prof. Johnson.

No. 12.—From same source. This analysis was evidently made from an exceptionally pure sample.

The first four analyses show an average of

Sulphur	2.87 *per cent.*
Ash	8.82 *per cent.*

Analyses of Farmville "Big" or Upper bed,—where thin.

	No. 13.	No. 14.	No. 15.
Water at 115° C.,	1.46	1.22	0.97
Volatile matter	29.30	31.77	27.53
Fixed carbon	40.24	46.54	36.93
Sulphur	4.33	3.79	10.74
Ash	24.67	16.68	23.83
	100.00	100.00	100.00
Weight of cubic yard, lbs.	2,359	2,323	2,317

No. 13.—Taken from pit (No. 20), 15 feet deep; the bed is here only one foot thick.

No. 14.—From shallow pit (No. 21); bed here 1′ 6″ thick.

No. 15.—From pit (No. 8). Bed is here about one foot thick.

Analyses of Natural Coke, "Big" Bed, Farmville.

	No. 16.	No. 17.
Water at 115° C.,	0.90	0.83
Volatile matter,	4.75	79.62
Fixed carbon,	68.33	
Sulphur,	0.92	0.87
Ash,	25.10	18.68
	100.00	100.00
Weight of cubic yard—lbs.,	2,798	....

No. 16.—Taken from shallow pit (No. 1), within ten feet of good coal.

No. 17.—Analysis from same sample.

Analyses of Middle or "Fourteen-inch" Bed, Farmville.

	No. 18.	No. 19.
Water at 115° C.,	1.29	1.50
Volatile matter,	30.25	29.32
Fixed carbon,	55.76	57.62
Sulphur,	2.88	2.34
Ash,	9.82	9.22
	100.00	100.00
Weight of cubic yard, lbs.,	2,244	2,280

No. 18.—From a small bed lying 5 feet above the lower bed in Pits Nos. 6 and 13.

No. 19.—Taken from the same locality.

II.—EGYPT SHAFT.

The old shaft at Egypt is not more than one mile and a half in a direct line west from Farmville, but is on the opposite (south) side of the Deep river.

It is supposed that the outcrop of the "Big" bed lies in or close to the river at the bridge, but the surface here is made up of alluvial drift and the outcrop of the coal is not visible. The shaft is about 1,500 feet from the river and struck the coal at a reported depth of 423 feet, its total depth being reported as 460 feet, this being doubtless the point at which the lower or two-foot bed was struck, the interval between the two beds being reported as 30 feet. A small intermediate bed is reported between these two seams.

Col. Laidley* gives the following measurement of the "Big" bed at the Egypt shaft:

Coal, top bench,	4′ 0″
Slate (black-band),	1′ 6″
Coal, bottom bench,	1′ 10″

He also speaks of "a vein of coal seven inches thick under six inches of slate" apparently meaning that this occurs beneath the "bottom bench," but states that it "is not at present worked." This slate and coal here referred to probably are the slate and coal found under the *lower bed* of coal and not beneath the lower bench of this upper bed.

Information derived from persons still living in the vicinity who had worked in this mine enables me to give the following additional facts (?). It seems that the upper bench of coal only reached four feet at its thickest points and that it averaged not more than three feet; that in the rooms driven up the dip rolls were encountered which pinched the coal down to small size, the coal coming in again of normal size in a few feet; that zones of natural coke (carbonite?) were found in the gangways driven east, and that the coal was cut by a fault in the west gangway; that the lower bench furnished a very poor quality of coal and was not worked in the rooms, but was raised along the gangways to gain head-room.

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*Report printed by order U. S. House of Representatives, June 10, 1856.

It appears that this colliery was never financially successful, its output was never large, gas was troublesome and the airways of insufficient size to maintain adequate ventilation, and to this cause may be attributed a series of explosions that proved costly and disastrous, and to which the financial failure of the operation was doubtless partly due.

At present the colliery is a total wreck. The shaft has caved in and the head-frame rotted and fallen into the shaft; the boilers are partly dismantled, the engines badly rusted, and the great brick smoke-stack is almost ready to fall, if indeed it has not fallen before this is printed, the lower courses of masonry being built of a light colored sandstone that has disintegrated rapidly so that it can now be broken off and crushed to sand in the palm of the hand. I append the following analyses of the coal.

Analyses of coal from the Egypt shaft.

	No. 20.	No. 21.	No. 22.
Water,	0.84	......	......
Volatile matter,	25.74	34.80	32.70
Fixed carbon,	63.28	63.60	60.70
Ash,	10.14	1.60	5.30
	100.00	100.00	......
Sulphur,	1.35	......	1.30
			100.00

No. 20.—From Prof. Kerr's report, made by Dr. F. A. Genth.

No. 21.—From Emmons' report, made by Dr. Jackson and evidently from a sample of exceptional purity.

No. 22.—From Admiral Wilkes's report, by Prof. Geo. C. Shaeffer.

Unfortunately we have no means of ascertaining the character of the samples from which these analyses were made, whether they were mere hand specimens (single average or best picked lumps) or true average samples, and in the absence of this knowledge the value of these analyses is quite small.

A section of the measures passed through in sinking this shaft has already been given in chapter I, Fig. 2.

III.—TAYLOR PLACE, AND EAST EDGE OF GULF PROPERTY.

The old workings on the Taylor place were close to the Gulf property line as shown by the accompanying sketch, Fig. 9, which shows the connection between the developments made here on both places. When I first visited these workings, I was at once impressed by the marked difference between the coal being mined by Mr. Williams, who has charge of the Gulf property, and that mined from the "Big" bed at Gulf and Farmville, and shortly after when the existence of two beds was proven at the latter place, I became convinced that this slope was opened on the *lower* bed and not upon the same bed as that developed by the old workings immediately adjacent on the Taylor place. Mr. Williams was then driving east toward the latter place, but reaching the line without breaking into the old workings, he found upon examination of the surrounding area that his slope was opened on the lower bed. This slope was sunk to a depth of over one hundred feet, when a pinch or roll was met which discouraged further developments. This work was done some four or five years ago by Messrs. Dewees and ———, of Pottsville, Pa.

On the east side of the slope the bed continues across the line to and upon the Taylor property in tolerably fair condition. West of the slope a fault or pinch was met and the work was not prosecuted far in that direction. It is a somewhat suggestive fact that the "Big" or upper bed disappears in this direction, its place being occupied by red clayey shale apparently belonging to the upper series of red sandstones and shales.

The shafts sunk in search of this bed here plainly show the existence of a fault throwing the bed far to one side, or what is perhaps more probable, a replacement of the bed and its accompanying slates by these red measures, the coal and slates having been eroded before the deposition of the upper red measures and these then laid down in the eroded channels.

DEVELOPEMENTS AT TAYLOR AND GULF PROPERTY LINE.

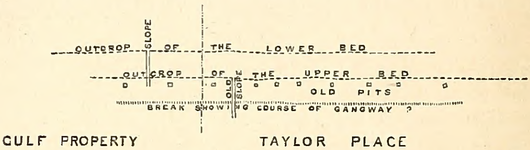


Fig. 9.

On the Taylor place the development has been confined to the upper bed. It is reported that a large number of pits and boreholes have been sunk in the low ground (swampy) east from the old slope in search of the coal, but evidently without success for no pits are now known where any traces of coal can be found. The old slope was sunk to considerable depth and at least one gangway was driven both right and left for some hundred feet. This gangway was about thirty or forty feet (vertically) below the surface and its location is now plainly marked by a trench formed by the settling of the ground over the old workings. A large number of crop-falls and old pits mark the outcrop for a distance of several hundred feet.

I put down two shafts here near the old slope. In the first the water was found quite strong and the shaft was not sunk to the coal. In the second the coal was struck just below water-level and well exposed. About one ton was taken out, an average sample of which analyzed by the State chemist gave:

	No. 23.
Water at 115° C.,	1.67
Volatile matter,	35.45
Fixed carbon,	55.39
Sulphur,	2.03
Ash,	5.46
	100.00
Weight of one cubic yard, lbs	2,221

The coal is bright and black containing very little visible iron pyrites and equal in quality to that obtained at Farmville and Gulf.

As the developments here were confined to the upper bench, we did not have an opportunity to measure the black-band and lower bench.

This upper bench where struck by the shaft measures almost exactly three feet of good clean coal with a slate roof and black-band or slate floor. A face of the coal cleaned off for measurement at the old slope showed about three and a half feet of coal, but the thickening was caused by a local pot-shaped depression in the floor. It will not be safe to assume the presence here of more than three feet of workable coal.

This upper bed lies about thirty feet above the lower bed opened by slope on the adjoining property.

A sample of coal taken from the pile of about 400 tons mined by Mr. Williams from the lower bed yielded on analysis:

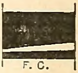
	No. 24.
Water at 115° C.,	1.87
Volatile matter,	32.78
Fixed carbon,	59.96
Sulphur,	1.37
Ash,	4.02
	100 00
Weight of one cubic yard in lbs.,	2,179

This analysis is deceptive, the sample secured not being a true average of the coal. An inspection of the coal itself shows at once that it is high in both ash and sulphur, and this is also clearly shown by the behavior of the coal in the fire. It is a very strong steam coal, but leaves a large quantity of ashes and cinder and contains much sulphur.

This lower bed is strikingly similar to the lower bed at Farmville with which it is doubtless identical. Mr. Williams gives as an average measurement:

Coal,	2′ 0″ to 2′ 6″
Slate,	4″ to 6″
Coal (bright),	5″ to 6″
Fireclay floor,	

Fig. 10



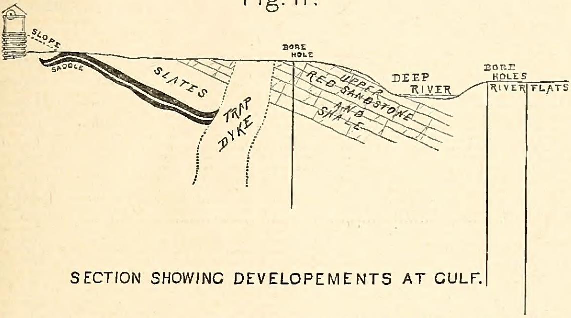
In quality and character it also resembles the Farmville lower coal. It is a strong steam coal, rather high in sulphur, and unless carefully mined and the slaty coal separated by hand will run high in ash and will then clinker badly. It seems to show the same kind of impurity (clay) in its upper layers as at Farmville, where I considered the upper 5 to 8 inches as waste. The small bench of coal (absent at Farmville) underlying the slate, which at Farmville forms the floor of the bed, is suggestive of the variations to which these beds seem subject.

IV.—EXAMINATIONS AT GULF.

The coal opened on the eastern edge of the Gulf property has just been described. More extensive operations have been carried on at the Gulf (village) proper. Here the upper or "Big" bed has been known for many years, and the outcrop has been "hogged over" by surface workings for a distance of several hundred feet. A slope was put down here before the war (but this is now almost obliterated), and I believe some coal was mined and shipped from it. Within a few feet of this old slope, Messrs. Dewees & Co., of Pottsville, Pa., sunk a new slope some four or five years. I am informed that in all the openings made here the coal was lost at a depth of something over seventy feet, being apparently cut off by a trapdyke, which shows boldly on the surface in close proximity to the workings.

I have attempted to show the structure as developed by these workings by the accompanying sketch section,—Fig. 11,—but as the slope was full of water during this exploration and a personal examination of the lower part of the workings could not be made, the section is necessarily constructed from information obtained at second hand.

Fig. 11.



SECTION SHOWING DEVELOPEMENTS AT GULF.

The property is now being prospected with a diamond drill by the present owners (Bostonians), and as they will undoubtedly thoroughly explore it, it was not considered necessary to make any excavations at this point. The coal was well exposed for examination in the slope, and in some pits sunk by Mr. A. B. Williams who had charge of the property. I believe the coal may be considered as averaging from three to four feet in the upper bench, with about eighteen inches of slate and black-band and eighteen inches to two feet of coal in the lower bench, but the bed is so variable that no one measurement can be taken as representative of its average thickness. Thus, in one place, Mr. Williams states that the coal measured:

Coal—upper bench,	6′
Slate and Black-band,	3′
Coal—lower bench,	3′

but the coal was much crushed, and this abnormal thickness was evidently caused by a "squeeze" and therefore purely local.

The location of three diamond drill-holes south of the trap-dyke is shown by the section, Fig. 11, but as the proprietors have not yet made public the record of these prospecting holes, no attempt is made to show the position and depth of the coal on this side of the dyke.

The outlook here, so far as thickness of coal is concerned, is more favorable than at any other point yet discovered, and in quality also the coal ranks with the best found in this coalfield. This is shown by the following analyses:

	No. 25.	No. 26.
Water at 115° C.,	1.65	1.16
Volatile matter,	27.50	21.90
Fixed carbon,	63.66	70.48
Sulphur,	1.44	....
Ash,	5.75	6.46
	100.00	100.00
Sulphur,		1.02

No. 25.—Analysis by State chemist from a sample taken from three or four tons of coal.

No. 26.—Analysis made by Dr. F. A. Genth for Prof. Kerr.

The principal difficulty experienced in attempting to develop this property is found in the existence of (at least one and perhaps several) trap-dykes. This feature is shown by the section, Fig. 11, and need not be dilated upon here as it will be discussed in the following chapters. Owing either to irregularities of deposition, or to the disturbance caused by the dykes, or to both, the coal has been found at its outcrop for a distance of only a few hundred feet. The trap evidently cuts it off to the east as no outcrop of the bed can be found at the village, and to the west, while the coal slates show in force along the road, the coal is apparently quite thin. The lower (?) bed has been found in a well near the railroad (in the village), and is reported as being less than two feet thick.

BETWEEN GULF AND EVANS' PLACE.

Explorations made in the past upon the western part of the Gulf property near the Tysor place evidently failed to find the coal in good condition. Two or three slopes were sunk here at which considerable work has evidently been done, but the reports not being favorable and the appearance of the openings and dumps being extremely unfavorable, I did not consider it necessary to re-open these pits, especially as much work has recently been done on this property by northern capitalists, and as they did not open at these places the inference that the prospect was not favorable enough to justify further work received additional and forcible support. Moreover as the property is now being thoroughly prospected by the present owners (Metropolitan Bank of Boston), with a diamond drill, at a cost of probably three or four times as much as was appropriated for this exploration of both the Deep and Dan river coalfields, the results so obtained will doubtless determine the value of this property independently of any work that might be done by the State.

Explorations on the Tysor and Palmer places had also evidently failed to disclose the existence of coal of workable quality and thickness, if we may place any faith in the recollections of the residents (and in this I think we may), and as the openings made on the Evans place at the old workings were of such discouraging character, I did not feel justified in making any openings on these intermediate plantations, *i. e.* between the Gulf property and the Evans place.

V.—SLOPE AT THE EVANS PLACE.*

The old slope at this place is said to have been sunk to a depth of over two hundred (250—260) feet on the bed, work having been vigorously prosecuted here for a time during the war. The main slope is now closed by a crop-fall, and the coal was opened for examination by cleaning out an old shaft that had probably been used for ventilation. This shaft communicated at the bottom with a gangway driven south-west from the slope at water-level. It was thirty-eight feet deep, and the gangway with which it communicated must have been started from the slope at a slant depth of about ninety feet. The gangway was still open to the south-west from the shaft, and was explored for a distance of about fifty feet, the *coal above it* being found intact, but that below had been partly mined out.

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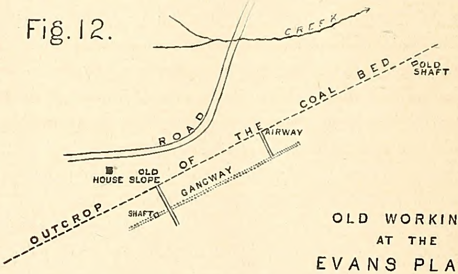
*This is sometimes spoken of as the "Carbonton mine" from its proximity to that village.

Fig. 12.



OLD WORKINGS AT THE EVANS PLACE.

About four hundred feet north-east from the slope an airway was found that was still open and accessible down to the water-level gangway. It had been driven up from this gangway to the surface on the slope of the bed.

At the shaft Mr. Shirley made the following measurement:

Slate, clay, and decomposed slate,	32′ 4″
Coal with some slate,	1′ 6″
Slate and black-band,	1′ 6″
Coal,	2′ 8″
Black slate floor,	

The workings are all on this lower 2′ 8″ bench. Some coal was taken out here and found loaded with iron pyrites. This probably accounts for the fact that the coal developed by the water-level gangway had not been mined, it being too sulphurous for use. At other points the presence of sulphur in large quantity was not so obvious.

The following analysis was made by the State chemist from a sample selected from *the best coal* we found at the shaft:

	No. 27.
Water at 115° C.,	4.25
Volatile matter,	4.91
Fixed carbon,	74.59
Sulphur,	2.13
Ash,	14.12
	100.00
Weight of one cubic yard, lbs.,	2,633

In the airway I found the workings were also evidently upon the lower bench, but the coal was not quite so thick here as at the shaft near the old slope. The coal appeared somewhat variable and it was difficult to select a place to make a measurement. The coal may be considered to average as follows:

Slate and black-band as the roof.	
Slate and coal,	6″ to 10″
Coal,	1′ 8″ to 2′ 0″
Slate floor,	

Part of the coal is poor and slaty and if the measurement included only the *good coal*, the figures would be much smaller. The whole bed, therefore, may then be considered as showing on an average measurement:

Coal (upper bench not worked),	1′ 2″ to 1′ 6″
Slate and black-band,	1′ 6″
Slate with some coal,	6″ to 10″
Coal (lower bench),	1′ 6″ to 2′ 0″

This bed is doubtless identical with the "Big" bed at the Gulf, Egypt and Farmville, but in a sadly deteriorated condition. The upper bench which at these localities carries the best coal, is here too thin to be worked, and the lower bench is not only thin but of poor quality yielding very little good coal.

The coal has the character, lustre, fracture and general appearance of a semi-anthracite coal, but might also be classed as semi-bituminous.

BETWEEN THE EVANS AND GARDNER PLACES.

In this stretch of country we made no excavations. The prospect at the Evans place and the unfavorable character of the developments on the Gardner, Murchison and Fooshee plantations seem to condemn this intermediate area, and as from the Evans place south-west to the river at the Murchison-Fooshee fording, the carbonaceous slates are so well exposed by repeated natural outcrops that any coals they might contain could not well escape detection, and as no coal had ever been opened in this area, I did not feel justified in spending any money in exploring in such an unpromising locality.

SEMI-ANTHRACITE AT WILCOX PLACE.

For precisely the same reasons no excavations were made at the Wilcox place, where from all accounts the bed is quite thin and has been badly broken by faults or trap-dykes and the coal altered to a semi-anthracite,—moreover the area here is too small to be of much importance.

Analyses of this coal are given by Prof. Emmons as made by Prof. Johnson as follows:

	No. 28.	No. 29.	No. 30.
Volatile matter,	8.28	6.64	7.35
Fixed carbon,	83.12	83.76	87.18
Ash,	8.60	9.60	5.47
	100.00	100.00	100.00
Specific gravity,	1.45	1.54	1.47
Color of ash,	Purplish gray—	Reddish gray—	ditto.

These analyses indicate a coal admirably adapted to the requirements of domestic use in heaters, grates and stoves, but inasmuch as they fail to show the sulphur percentage it would be unsafe to recommend them on this evidence. However, as the bed is reported as only two and a half feet thick (and is doubtless often smaller), as its developed area is quite small, and that area known to be troubled by faults, we may safely conclude that while at some future day a small mine may possibly be operated here to supply the local demand, the existence of the bed at this place will be of small practical importance to the commercial interests of the State. In many respects this Wilcox bed is similar to that opened on the Gardner place.

VI.—SEMI-ANTHRACITE (?) AT GARDNER PLACE.

The coal found at this place was opened at a natural outcrop in a ravine, and seems to be the same bed opened at the Murchison place, but the coal here has a semi-conchoidal fracture, lustre and general appearance closely approaching that of a true anthracite. I instructed Mr. Shirley to drive in on this bed, and upon starting a drift at water-level we found hard black coal after driving only a few feet. The total thickness of the bed as exposed by this drift is about two feet and eight inches, with a few inches of very slaty coal on top and two (sometimes three) slate partings from one quarter of an inch to one inch thick dividing the coal into benches of very nearly equal size. The lower part of the bed is evidently high in ash; the coal between the slate partings is clean and good, there being two such layers respectively five and seven inches thick. An analysis made by the State chemist from a sample of *the best coal* gave:

	No. 31.
Water at 115° C.,	1.73
Volatile matter,	6.38
Fixed carbon,	80.01
Sulphur,	2.75
Ash,	9.13
	100.00
Weight of one cubic yard, lbs.,	2,480

I believe this bed is too thin and contains too much slate to be of any present value. If the surrounding country was thickly peopled and wood scarce, the coal would doubtless be worked to supply the local demand. To successfully compete with other purer fuels it would be necessary to clean this coal thoroughly from the interbedded slate by hand picking and jigging. The hardness of the coal and the large quantity of refuse would increase the cost of mining so that the coal delivered at the mouth of the mine would cost from 75 to 100 per cent. more than that of the soft bituminous coal of Gulf, Farmville, etc., and the cost of preparation would also add largely to the cost. I believe coal mined from this bed properly cleaned and prepared for market would cost the operator not less than three dollars ($3.00) per ton.

VII.—MURCHISON PLANTATION.

This lies south-west from the Gardner place. Four or five old pits were sunk here many years ago, at all of which traces of coal may be found in the waste piles. Upon attempting to clean out one of these shafts in which the remains of small wooden hand-pumps were found, the ground around the bottom of the

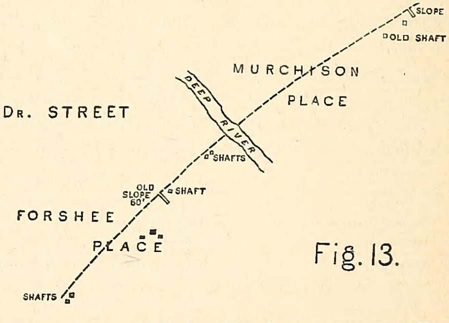


Fig. 13.

shaft was found undermined by old workings and as these were full of water and a semi-fluid mud, I abandoned the work at this pit and examined the coal by means of two openings made close by,—one upon a natural outcrop in a ravine, the other by a slope driven down upon the bed some twenty feet or more. The sample from which analysis No. 32 was made came from this opening, where the bed measured:

Slate roof	
Slaty worthless coal,	6″ to 8″
Coal with several thin slaty seams,	2′ 2″ to 2′ 6″

The bed is quite irregular in thickness and it is rather difficult to select a proper place to make a measurement, and the slaty bands are scattered through the beds, not dividing it into well-defined benches. Upon trying to burn this coal upon an open fire I found it difficult to ignite, and but a small part burnt to ashes, most of it leaving large cinders such as are left by long coal and bituminous slate—in other words, resembling burnt slate—thus showing conclusively the presence of a large percentage of impurities.

A sample of the best coal found here yielded, on analysis by the State chemist:

	No. 32.
Water at 115° C.,	1.49
Volatile matter,	14.20
Fixed carbon,	59.11
Sulphur,	5.37
Ash,	19.83
	100.00
Weight of one cubic yard, lbs.,	2,391

VIII.—FOOSHEE PLANTATION.

At this place we sunk five shafts, varying from ten to twenty feet, or thereabouts, in depth, and found the coal at three different places, which were about one-quarter and one-half mile apart. It was reported that the bed which had been developed by a slope to a depth of forty to sixty feet some twenty-five or thirty years ago, was five feet thick. Prof. Emmons states (probably on hearsay evidence) that they (the coal-beds) "are equal in thickness * * * to * * * those of Egypt."

The new openings were made alongside of the old pits and slope. At the pit farthest from the river less than one foot of coal was found. At the old slope there is a bed of carbonaceous slaty shale about four feet thick, beneath which about eight to ten inches of impure coal was found. The shale overlying the coal has the graphitic appearance so common in many other parts of this coalfield, and was doubtless mistaken for coal by the early explorers, its thickness corresponding very nearly with the reported thickness of coal.

At the pit nearest the river the same bed was found, and in practically the same worthless condition, showing less than one foot of coal of rather poor quality.

Farther east and upon this same plantation a bed of graphitic slate is exposed by natural outcrops in a ravine. This has also been mistaken for coal or for the outcrop of a coal bed, and a pit was sunk upon it years ago, without, it is almost needless to say, finding any coal.

These facts certainly contain no element of promise, and should be sufficient to discourage all from expending money in useless search in this locality. Only an entirely new discovery of some other beds would warrant such expenditure, and such a discovery seems to me most improbable.

All the facts developed by this exploration point to this as the probable south-western limit of the coals. In a commercial sense, this limit must be placed much farther north-east, perhaps at the Murchison or even beyond the Evans place.

From the Gulf south-west towards this Fooshee place the coal seems to be steadily deteriorating in quality and thickness and in regularity of deposition, hence the conditions here shown by the explorations are not surprising.

CHAPTER IV.

COMMERCIAL VALUE OF THE DEEP RIVER COALFIELD.

In any inquiry into the availability of a coalfield for practical mining it is necessary to review the commercial relations of the district as compared with other competitive coalfields; to consider well the cost of mining and transportation, the quality of the coal and its quantity and the uses to which it seems best adapted. This chapter will be devoted to a discussion of these subjects and to a brief statement of the conclusions arrived at concerning the principal obstacles presented by this coalfield and the methods that should be pursued in developing it.

Avenues to Market.—The location of this coalfield constitutes the sole and preëminent advantage it has over other competitors in supplying the markets of Central and Eastern North Carolina and South Carolina. As regards the Atlantic coast markets it stands at a decided disadvantage to the Richmond field being 150 miles, while the latter is only 15 to 20 miles from tide-water.

For supplying the markets of North and South Carolina it has great advantages over the Tennessee and Pocahontas (Va.) coalfields, but has little if any advantage over the Richmond basin except for the inland markets. The following tables shows the distances in miles from each of these coalfields to the principal points in North Carolina and to a few points outside the State.

Table showing Distances in Miles from Coalfields to Markets.

TOWNS AND CITIES.	Deep River Coal.	Tennessee Coal.	Pocahontas, Va., Coal.	Richmond, Va., Coal.
Lynchburg, Va.,	165	475	172	111
Danville, Va.,	100	410	237	128
Greensboro, N. C.,	51	361	286	176
Salisbury, N. C.,	100	312	335	225
Charlotte, N. C.,	140	356	379	269
Spartanburg, S. C.,	215	431	454	344
Columbia, S. C.,	246	462	485	375
Durham, N. C.,	68	416	341	223
Raleigh, N. C.,	52	442	367	197
Weldon, N. C.,	149	....	356	100
Fayetteville, N. C.,	46	458	383	274
Wilmington, N. C.,	150	....	....	Ocean.
Statesville, N. C.,	125	287	360	250

Distances are estimated by nearest railway routes. These are shown by the map (Plate 4), which clearly demonstrates the advantageous geographical location of this coal territory.

Estimating the average freight charges at three-fourths of a cent per ton per mile, and at one-half per ton per mile, we obtain the advantage due to difference in haulage that the Deep River district would have over these other coalfields, as shown by the following table:

Difference in haulage cost in favor of the Deep River coalfield.

TOWNS AND CITIES.	TENNESSEE COAL.		POCAHONTAS COAL.		RICHMOND COAL.	
	Rate $\frac{3}{4}$c	Rate $\frac{1}{2}$c	Rate $\frac{3}{4}$c	Rate $\frac{1}{2}$c	Rate $\frac{3}{4}$c	Rate $\frac{1}{2}$c
Lynchburg, Va.,	$2.32	$1.55	$0.05	$0.03	$........	$........
Danville, Va.,	2.32	1.55	0.99	0.66	0.21	0.14
Greensboro, N. C.,	2.32	1.55	1.76	1.17	0.93	0.62
Salisbury, N. C.,	1.59	1.06	1.76	1.17	0.93	0.62
Charlotte, N. C.,	1.62	1.08	1.79	1.19	0.96	0.64
Spartanburg, S. C.,	1.62	1.08	1.79	1.19	0.96	0.64
Columbia, S. C.,	1.62	1.08	1.79	1.19	0.96	0.64
Durham, N. C.,	2.61	1.74	2.04	1.36	1.16	0.77
Raleigh, N. C.,	2.92	1.95	2.36	1.57	1.08	0.72
Weldon, N. C.,	....	....	1.55	1.03	....	....
Fayetteville, N. C.,	3.09	2.06	2.52	1.68	1.71	1.14
Statesville, N. C.,	0.99	0.66	1.76	1.17	0.93	0.62

As for several years to come the average haulage cost will probably not be much less than one cent per ton per mile, we may safely assume the figures of the first columns of the above table ($\frac{3}{4}$ cent rate) as applicable for the next few years. In all probability the one-half cent rate will not be reached for many years.

These figures show an encouragingly large margin in favor of the Deep River district, and we may now consider whether this margin is sufficient to defray the excess in cost of mining this coal over that of the other districts, and also to enable the operator to sell the coal at a sufficient reduction from the price of other coals to warrant its purchase if its quality is found inferior to the competing coals.

Cost of Mining.—Assuming an average thickness of two feet of workable coal, the cost of mining should not exceed one dollar and a half per ton. In many other districts this thickness could be worked for one dollar per ton or perhaps less, but here the coal must be worked below water-level and on a moderately steep dip, the coal must be hoisted, the water raised and thorough ventilation maintained to secure the mines from disastrous explosions.

As the cost of mining the Pocahontas and Tennessee coals is about 65 cents per ton (and perhaps somewhat less), the Deep river coal on the above assumption would stand at a disadvantage of 85 cents per ton.

With three feet of workable coal the cost should not exceed $1.20 per ton. On this supposition the Deep river coal would be at a disadvantage of 55 cents per ton. These figures subtracted from the difference in haulage cost will show the actual estimated margin in favor of the Deep river coal delivered at the points named.

Estimated Margins in favor of Deep River Coal.

TOWNS AND CITIES.	TENNESSEE COAL.		POCAHONTAS, VA., COAL.	
	Rate $\frac{3}{4}$c.	Rate $\frac{1}{2}$c.	Rate $\frac{3}{4}$c.	Rate $\frac{1}{2}$c.
Lynchburg, Va.,......	$1.77 to $1.47	$1.00 to $0.70	....	....
Danville, Va.,.........	1.77 to 1.47	1.00 to 0.70	$0.44 to $0.14	$0.11 to ....
Greensboro, N. C.,....	1.77 to 1.47	1.00 to 0.70	1.21 to 0.91	0.62 to 0.32
Salisbury, N. C.,......	1.04 to 0.74	0.51 to 0.21	1.21 to 0.91	0.62 to 0.32
Charlotte, N. C.,... Spartanburg, S. C., Columbia, S. C.,...	1.07 to 0.77	0.53 to 0.23	1.24 to 0.94	0.64 to 0.34
Durham, N. C.,.......	2.06 to 1.76	1.19 to 0.89	1.49 to 1.19	0.81 to 0.51
Raleigh, N. C.,.......	2.37 to 2.07	1.40 to 1.10	1.81 to 1.51	1.02 to 0.72
Weldon, N. C.,........	....	....	1.00 to 0.70	0.48 to 0.18
Fayetteville, N. C.,..	2.54 to 2.24	1.51 to 1.21	1.97 to 1.67	1.13 to 0.83
Statesville, N. C,.....	0.44 to 0.14	0.11 to	1.21 to 0.91	0.62 to 0.32

From these figures it appears that Pocahontas coal can control the Lynchburg market, and its very superior quality would perhaps also enable it to displace Deep river coal at Danville, although the latter has a margin of 14 to 44 cents in its favor at that point.

4

As opposing railway interests place the Pocahontas coal at a disadvantage to the Tennessee coal at many points, the figures under the Tennessee column only can be considered at the present time. At Weldon, however, and perhaps at Raleigh the Pocahontas figures should be taken.

At Weldon the Deep river coal would apparently have a margin of 70 cents to $1.00 in its favor.

At Raleigh, a margin of $1.51 to $1.81.

At Greensboro, a margin of $1.47 to $1.77.

At Salisbury, a margin of $0.74 to $1.04.

At Charlotte, Spartanburg, and Columbia, of $0.77 to $1.07.

At Durham, a margin of $1.76 to $2.06.

At Fayetteville, a margin of $2.24 to $2.54.

These figures are large enough to show that a very considerable reduction could be made in the price of coal and yet leave ample profit to the operator,—but it must be remembered that in practice the figures might be found to vary materially from the above estimates owing to conflicting or competing railway interests and the impossibility of securing a uniform tonnage rate on all the lines of railway.

QUALITY OF THE COAL.

From the analyses already given, it will be seen that the quality of these Deep river coals is by no means uniform. Some of these, especially those quoted from reports made in the past, make an extremely favorable showing, but I have not been able to learn that they were made from average samples. On the contrary I believe that in every case where the sulphur and ash percentages are both low, the analysis was made from specimens picked from the best coal. The samples selected for analysis in this work were generally true average samples, but when lump coal or the finest specimens were taken and not a general average of the bed, this fact is plainly recorded with the analysis.

It will be noticed that the analyses of samples from the lower bed at Farmville show widely varying percentages of sulphur and ash, although the samples were all taken at two shafts distant from each other only some 40 or 50 feet. The same holds true of the "Big" or upper bed; and while this variableness in quality has not been proven by analyses at Gulf, Egypt, and the Taylor place, an ocular inspection of the bed shows plainly that it is subject to similar changes at these points.

The ash percentage is often quite low, and the sulphur percentage is at times unobjectionable, and while most of the analyses show a rather large amount of sulphur, it is seldom enough to prohibit the use of the coal.

The analyses of the "Big" or upper bed at Gulf, Taylor place, Egypt, and Farmville represent coal of very fair quality and equal to that of many coals largely mined in the Northern and Western States.

We may, therefore, safely conclude that this coal, if carefully mined, would find ready sale and be largely used for all ordinary purposes, especially if sold for less than other coals with which it would come into competition.

The lower bed at Farmville and Gulf is an especially strong steam coal, and seems also well adapted for use in open grates and cylinder stoves.

The upper bed furnishes a more bituminous coal, coking very quickly and at a low temperature, and this peculiarity especially fits it for use in the blacksmith's forge. Used as a gas coal, the percentage of sulphur would probably be found objectionable, but by carefully selecting the coal and shipping only the purest coal for this use, this difficulty might be overcome.

The semi-bituminous and semi-anthracite varieties are especially adapted to domestic use, but would also make satisfactory fuels for steam and other purposes. However, where these varieties are found the coal is commonly either too thin or too impure for profitably working on a large scale.

In appearance these Mesozoic coals do not materially differ from coals of the same class found in the true coal measures. They are bright, black, and shining, and commonly have a well developed cubical or columnar structure. An impression that these coals resemble the Cretaceous lignites has obtained considerable foothold among mining men. Nothing could be more erroneous.

WORKABLE AREA.

The most promising area is that extending from Farmville on the east to the Tysor (adjoining the Gulf) place on the west. Within these limits coal of workable thickness and quality has been found at four points, namely: Gulf, Taylor place, Egypt and Farmville. East and south-west from this all the prospect is not promising as the coal opened in no case shows, in my opinion, either workable thickness or quality. It may appear to some that possibly other thicker and better beds exist in these localities whose presence is as yet unknown. In some coal districts this argument might have considerable weight, but in the area lying south-west from the Gulf property to the Fooshee place the coal bearing slates are so frequently exposed by natural outcrops in gullies and ravines and are almost everywhere so close to the surface that it seems incredible that any thick bed of coal could have escaped detection. This Deep river district has already passed through a period of inflated values, a "coal excitement," during which the whole country was thoroughly scanned for indications of coal, and wherever such were found excavations were made to test the coal and in some cases small quantities were mined and shipped away for practical trial. Hence I have no faith whatever in the possibility of the existence of any undiscovered bed of workable coal in this area, and believe the expenditure of money in further search will inevitably result in loss.

In the most promising area (Farmville to Gulf) we find coal good enough to command a very fair price for blacksmith and foundry use. Wherever such coal was found the outcrop has been competely "hogged over" by shallow pits and shafts sunk to obtain coal to sell to neighboring smith-shops, and to some located at a considerable distance, coal having frequently been hauled to Fayetteville and Raleigh.

In the area south-west from the Gulf there is an entire absence of evidence of any such activity doubtless owing to the fact that the coal was not readily saleable.

Returning, now, to the area that seems most promising and in which the existence of workable coal is proven, we may briefly consider some of its more important features with reference to its value from a commercial standpoint.

The length of the outcrop included between these limits is between four and five miles. Under the most favorable conditions we are not warranted in assuming the thickness of workable coal at more than five feet—three feet for the upper and two feet for the lower bed. If the dip of the coal continues as found at Egypt (423 feet in 1,500 feet), over the whole area, the coal could probably be worked to a vertical depth of, say 1,100 feet, which places the limit along a line parallel to the outcrop and about three quarters of a mile distant from it. Assuming the length of the outcrop at four and a half miles, the area is then 2,160 acres. If 2,500 tons per acre could be mined from the lower bed and 4,000 tons from the upper bed, we have for the available tonnage:

Upper, or "Big" bed,	8,640,000 tons.
Lower, or "Little" bed,	5,400,000 "
Total,	14,040,000 tons.

This is the most favorable showing that can be made, and is doubtless far in excess of the actual workable contents of this area, for no allowances have been made for those areas ruined by trapdykes, and for areas in which the coal is thin or even absent, nor for areas over which the coal is faulted or is too impure to ship. I believe that these irregularities will reduce the area by at least one-half, or say to 1,100 acres. It will also be safer to estimate the yield of the lower bed at 2,000 tons and the upper bed at 3,500 tons per acre. The available tonnage so calculated would then be:

Upper, or "Big" bed,	3,850,000 tons.
Lower, or "Little" bed,	2,200,000 "
Total,	6,050,000 tons.

Even if this calculation is still too large, and we cut it down to one-half (3,000,000 tons), the amount is sufficient to sustain a daily output of 500 tons for twenty years. If this coal cost the consumer only fifty cents per ton less than other coal the resulting economy would amount to one and a-half million dollars ($1,500,000) saved to manufacturers and other consumers throughout the State. In addition to this, probably a much larger amount would be saved by reason of the reduction in price of other coals, resulting from competition. In addition to these benefits, the profits made by the operators, the railroads transporting it and the employment afforded a large number of miners and laborers, should not be underestimated.

Again, three million tons of coal at an average price of $3.50 per ton cost over ten million dollars ($10,500,000). If this amount of money can thus be kept in the State instead of being paid out to the owners of mines in other States, the commercial value of this coalfield to the State can hardly be over-estimated.

OBSTACLES TO SUCCESSFUL MINING.

As knowledge of the obstacles presented by this coalfield is of great importance they will be described *seriatim* in the following order:

a.—Variations in thickness and quality.

b.—Faults.

c.—Trap-dykes.

d.—Presence of explosive gas,—fire-damp.

e.—Water.

f.—Spontaneous combustion (?).

g.—Absence of coal from some areas.

a.— *Variations in thickness and quality.*—These have already been described. These variations are commonly abrupt, the coal suddenly shrinking to one-half or one-third its normal size, and singularly enough, the ash seems to increase in inverse ratio as if all the impurities found in the bed where three feet thick were also present when the coal measures only one foot. This phenomenon is not peculiar to this coalfield as I have noticed it at several localities in Pennsylvania. Such irregularities will prove fatal to the financial success of any operation unless their existence is known and their limits thoroughly defined in advance of actual mining, for it seems absolutely essential to plan the work in advance with reference to these variations.

b.—*Faults.*—Rolls and displacements of the coal measuring a few feet were found in the workings at Egypt and Farmville. In mining the coal for the Raleigh Exposition we encountered two local rolls. Extensive developments might disclose the existence of greater dislocations which would materially increase the cost of mining,—however, the faults known to exist, aside from those caused by trapdykes, would not seriously interfere with successful mining.

c.—*Trapdykes.*—At many points the coals are intersected by dykes as shown by the Farmville, Egypt and Gulf workings, and they seem to be the most serious obstacle yet encountered. It seems of the utmost importance that the exact position and extent of these dykes should be determined upon any property before planning its development. This can only be accomplished by a complete system of bore-holes dotted over all the area to be worked, as is being done at present by the owners of the Gulf property. This is the only safe method.

d.—*Fire-damp.*—The presence of fire-damp is proven by the occurrence of several explosions at the Egypt shaft. I am informed that "blowers" of gas were frequently struck. In mining a bed of this (three feet) thickness the presence of gas must increase the cost of mining, for it necessitates the establishment and maintainance of large airways to secure adequate ventilation to dilute and carry off the gas.

e.—*Water.*—These rocks do not carry very large quantities of water, and it is not likely that heavy pumping machinery would be needed.

f.—Spontaneous combustion (?).—In the Richmond coalfield great trouble has been caused by what is called spontaneous combustion. Judging from the similarity of the coals it seems possible that this same difficulty may obtain here. While this is a mere supposition, it is one that cannot safely be ignored. Mine fires are such serious disasters that every possible precaution should be taken to prevent them, and when there is any reason to suspect the possibility of spontaneous combustion, it seems essential to anticipate the danger by any possible precautionary measures that can be taken.

g.—Absence of coal over certain areas.—The failure to find the outcrop of the coal between Egypt and the Taylor place and between the latter place and the Gulf workings, and the demonstrated absence of the coal on parts of the Farmville property are sufficient evidence that over some areas the coal is entirely absent. It has not been possible to define the exact limits of such areas. This must be done by the individuals or companies owning or operating each tract. To ignore the existence of such barren areas and to plan developments upon the assumption of a continuous unbroken bed of workable size would be to invite failure, and as such a plan would inevitably be followed by disheartening failures in many if not in every case, it seems necessary to determine the exact limits of such areas in advance of developments and before the coal is actually opened for mining. A complete series of bore-holes is necessary to give this information, and these holes must be located only short distances apart.

METHOD OF DEVELOPMENT.

The methods necessary to insure financial success in operating in this district have already been indicated. The tract to be developed should be completely riddled with bore-holes to determine the local condition (thickness, quality, depth) of the bed at every point before attempting to open the coal for actual mining.

Slopes will probably be preferable to shafts unless the coal is found much disturbed by faults or trap-dykes. Large airways will be necessary to insure safety from explosions, and ventilation should be maintained by fans and not by furnaces.

GENERAL CONCLUSIONS.

From the detailed descriptions of the explorations made at different points in this Deep River district the reader will doubtless be able to deduce conclusions as to its value and the possibility of mining being carried on remuneratively. For the convenience of those not interested in these details, or not sufficiently familiar with coal properties to perceive their import, the following *resume* is here subjoined.

1. That a bed of coal of good quality free from slate may be considered workable in this district if twenty-two or twenty-four inches thick.

2. In the area between Farmville and Gulf, a distance of about four and a half miles, two beds of coal exist that may be considered workable; that these beds are not of workable thickness and quality over all of this area, but are subject to the occurrence of deteriorated patches in which the beds are poor and thin; that it is not unlikely that the workable areas are disconnected, that is the coal may not be continuously workable from one locality to that next adjoining.

3. That the most promising area seems to be that lying between the openings on the Taylor place and Egypt.

4. That the disturbances occasioned by trapdykes and the presence of the dykes are serious impediments to successful mining.

5. That the coal found in the above described area is often sufficiently good to insure ready sale, but that to make and maintain a reputation that would insure a market it might be necessary to leave untouched those parts of a mine in which the coal was rather more sulphurous or more slaty than the average.

6. That it will be unsafe to attempt opening any property for mining until it has been thoroughly explored by bore-holes, and the position and extent of trap-dykes, faults and other irregularities thoroughly determined.

7. That in the above described area the prospects are sufficiently encouraging to warrant a thorough exploration of each individual tract by the land-owners.

8. That in the present state of development the prospect does not justify the present owners in asking nor purchasers in paying for the land a sum much in excess of its value for farming purposes.

9. That in the area east from Farmville and south-west from Gulf the developments do not justify further expenditures in search for coal. This conclusion is subject to one qualifying exception, namely: If a market could be found for the anthracite coal of the Evans, Gardner and Wilcox places at a price approximating that commanded by Pennsylvania anthracite for domestic use, these coals could be worked, but the margin of profit would be precariously small and the output necessarily limited. To properly mine and prepare these coals for domestic use would require a method of preparation similar to that used in the Pennsylvania anthracite coalfield. The coal must be broken, sized, screened, picked for slate and perhaps jigged. The cost would probably exceed three dollars per ton. The coal would not be likely to sell for more than three-fourths the price of Pennsylvania anthracite.

CHAPTER V.

THE DAN RIVER COALFIELD.

It should be stated at the outset that this district cannot truthfully be termed a "coalfield," as the coal occurs merely as sporadic deposits of quite limited extent and is too thin, irregular and uncertain to be of any commercial value.

The district is similar in nearly every respect to the Deep River country except that the middle slate series is much better developed as to thickness and extent, but the slates here often more resemble shales, and are of a lighter grayish color. This slate formation contains many bands of black, bituminous and carbonaceous fissile slates, which are frequently mistaken for the outcroppings of coal beds.

The slates can be traced without trouble from near the Virginia line south-west to near Germanton.

At Stokesburg we made a number of trial pits, and made one drift about fifty feet long.

This drift and some four or five shallow pits were located about one mile from the town. They were opened on a bed of carbonaceous slate which occasionally contained thin streaks of coal ($\frac{1}{4}$ to 1 inch thick), both anthracite and bituminous. In places the carbon of the slate was converted into graphitic films, which gave the rock a slippery, glistening appearance. This bed of slate had frequently been reported as a bed of coal six feet thick. It is almost needless to say that it is entirely worthless.

At Stokesburg we found several similar beds of slate, and at one hole which was sunk on the slope of the bed, we found a deposit of coal which measured from twelve to fifteen inches in thickness. This is a purely local deposit and is entirely worthless. On one side of the pit it pinched down to nothing, and on the other side was only a few inches thick. It is underlaid by hard slate about one foot thick, beneath which another impure layer of coal occurs. A specimen of the best of the coal obtained here was sent to the State Exposition. It is anthracitic in chemical composition, but has an irregular, angular fracture, not conchoidal. In burning it gives off sulphurous fumes in quantity.

I also examined a pit that had been sunk upon a supposed coal bed about one mile and a half south-west from Stokesburg, but found only a bed of slate with a few streaks of impure coal.

The fact that none of these beds is underlaid by fireclay is enough to discourage any one from expecting to find any regular coal deposits here.

About two miles south-west from Leaksville a great deal of work has been done upon a seam of coal on the Wade place. An average measurement of the bed here as made from examinations at several places gave:

Sandy slates and shale roof	
Coal,	1′ 0″
Slate,	7″
Coal,	1′ 1¾″
Slate floor, exposed,	1′ 0″

Eight or ten feet above this bed there is a thin seam of coal six inches to one foot thick. Several thin coaly seams have been found below the main bed.

From the number of tunnels and slopes that have been driven to develop this coal bed, I should judge that not less than $15,000 or $20,000 has been spent here.

The bed has been found for nearly half a mile which probably represents its actual limits, it being evidently a purely local deposit.

The following analyses show the coal to be anthracitic, but very high in ash and objectionably high in sulphur.

It is entirely useless to consider any attempt to mine this coal in view of the cheap Pocahontas coal with which it would come into competition. The cost of mining would be very greatly increased by the thick slate parting, which is undoubtedly persistent.

The analysis of the upper bench shows:

	No. 1.
Moisture,	11.67
Volatile matter,	30.19
Fixed carbon,	48.00
Sulphur,	0.49
Ash,	9.65
	100.00
Weight of cubic yard, lbs.,	2,828

The high percentage of moisture is evidently accidental.

The lower bench shows, on analysis:

	No. 2.
Moisture,	5.35
Volatile matter,	9.49
Fixed carbon,	64.31
Sulphur,	0.58
Ash,	20.27
	100.00
Weight of cubic yard, lbs.,	2,778

An average sample from both benches gave, on analysis:

	No. 3.
Moisture,	3.92
Volatile matter,	5.47
Fixed carbon,	73.95
Sulphur,	2.44
Ash,	14.22
	100.00
Weight of cubic yard, lbs.,	2,711

A sample picked from the best coal that could be found here gave, on analysis:

	No. 4.
Moisture,	3.70
Volatile matter,	4.67
Fixed carbon,	81.58
Sulphur,	2.23
Ash,	7.82
Weight of cubic yard, lbs.,	2,694

At a place where coal had been reported, on the Sharp plantation, we cleaned out an old pit and sunk it somewhat deeper upon an entirely valueless bed of slate, which measures:

Slate—blue, carbonaceous,	1′ 6″
(*a*). Coal and slate, variable,	6″
(*b*). Slick graphitic slate, with coal streaks,	1′ 0″
(*c*). Blue carbonaceous slate,	

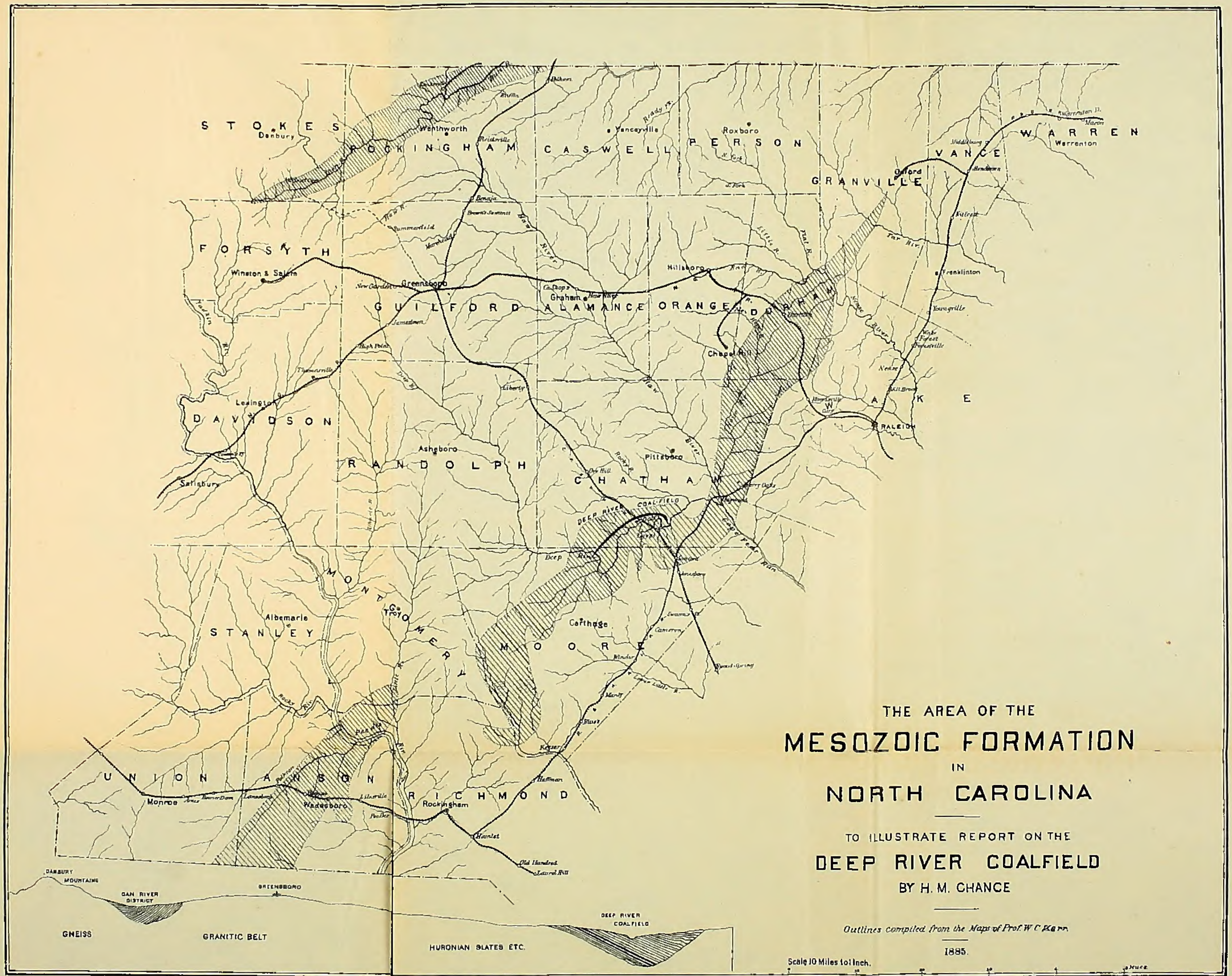
Samples were analyzed from *a*, *b* and *c*, with the following results:

(*a*).	*No.* 5.
Moisture,	1.65
Volatile matter,	4.82
Fixed carbon,	55.76
Sulphur,	4.76
Ash,	33.01
	100.00
Weight of cubic yard, lbs.,	3,199

(*b*).	*No.* 6.
Moisture,	2.04
Volatile matter,	6.03
Fixed carbon,	15.25
Sulphur,	1.47
Ash,	75.21
	100.00
Weight of one cubic yard, lbs.,	3,333

(*c*).	*No.* 7.
Moisture,	2.49
Volatile matter,	6.08
Fixed carbon,	2.90
Sulphur,	0.53
Ash,	88.00
	100.00
Weight of one cubic yard, lbs.,	4,310

From all the facts gathered in this examination of the Dan River district it seems certain that it will be entirely useless to expect to find workable coal beds. The small seams of coal that do exist are local deposits, without thickness, purity or continuity. It is, therefore, idle to pursue the subject further.



THE AREA OF THE

MESOZOIC FORMATION

IN

NORTH CAROLINA

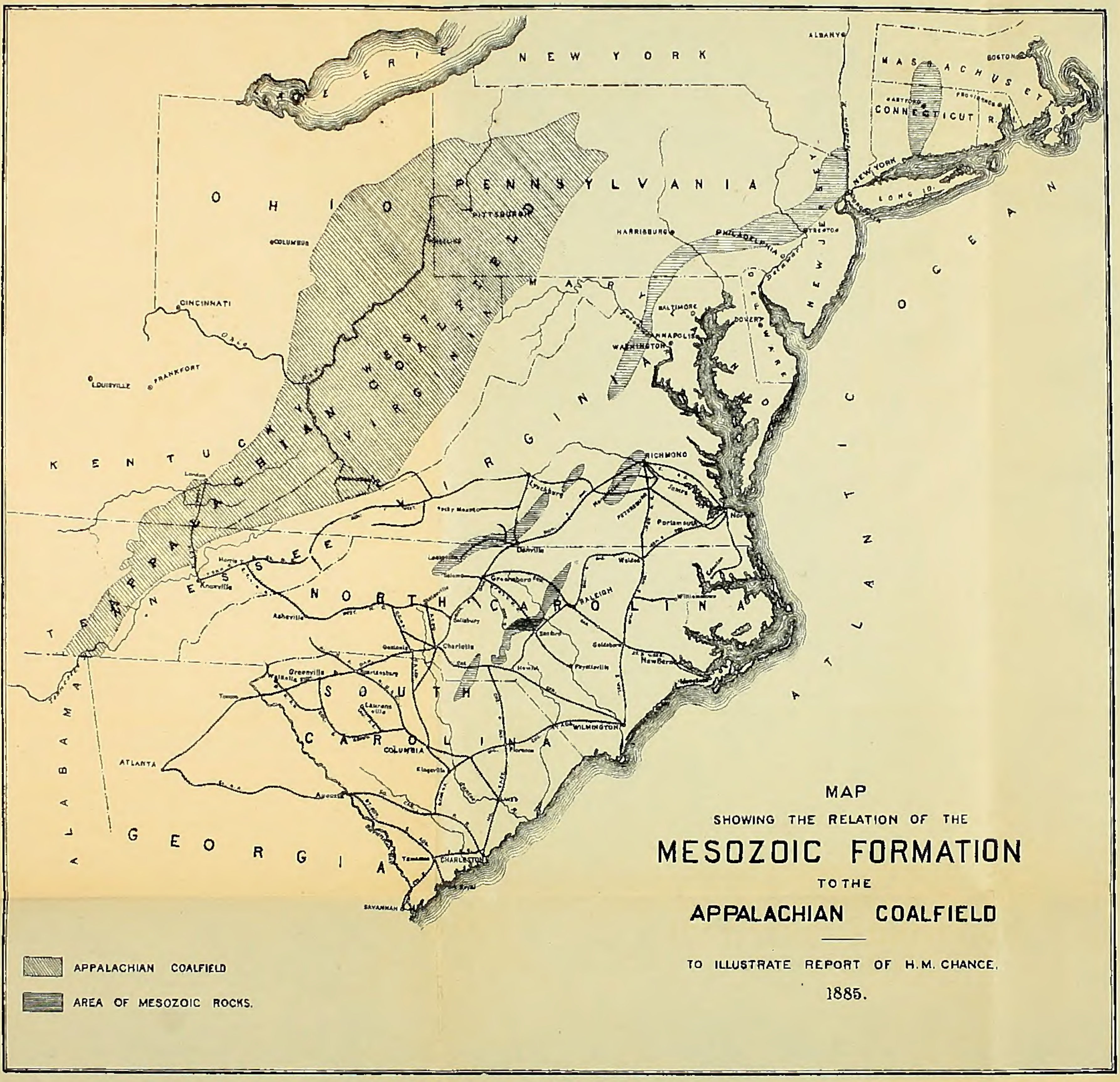
TO ILLUSTRATE REPORT ON THE

DEEP RIVER COALFIELD

BY H. M. CHANCE

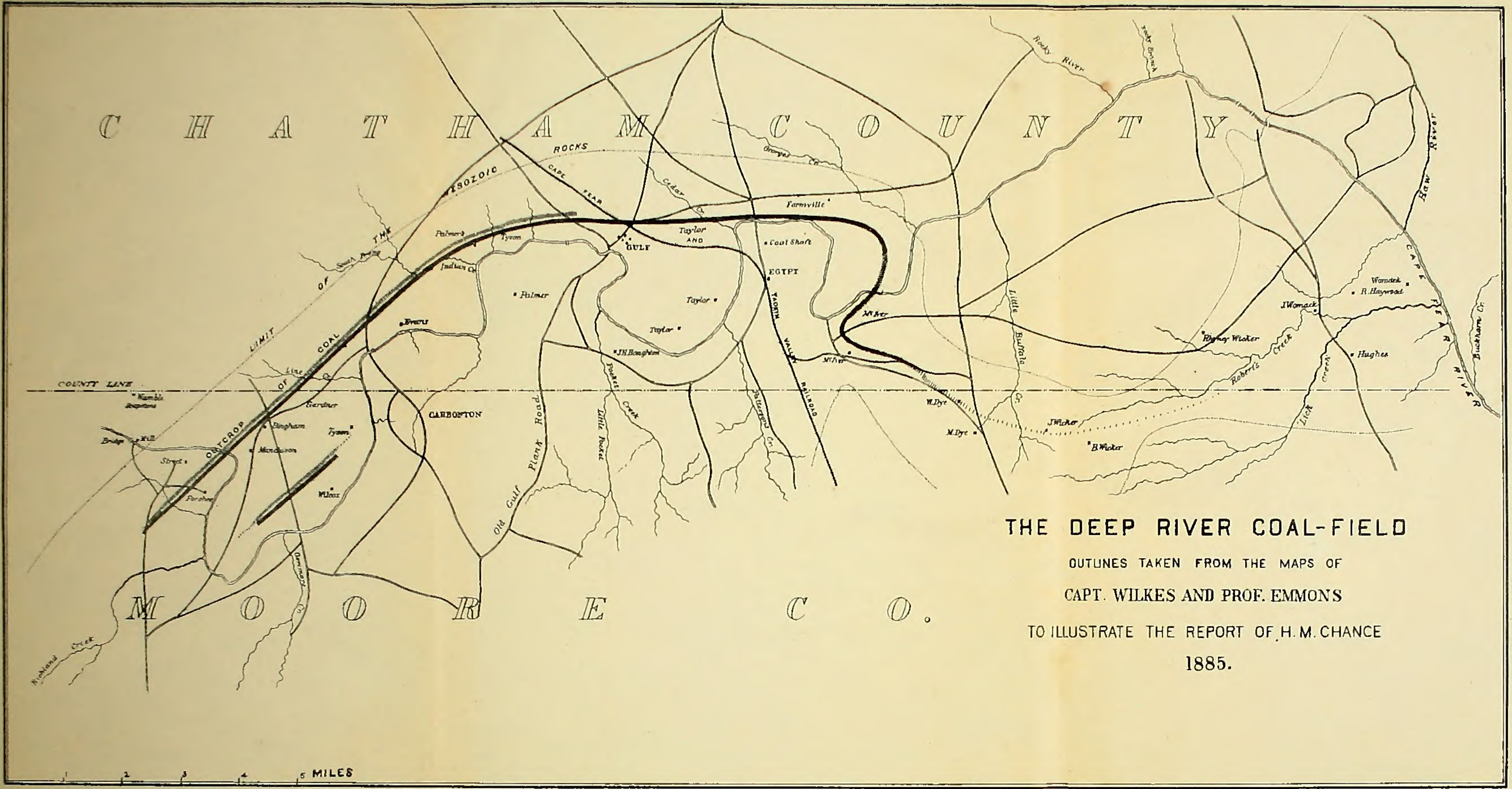
Outlines compiled from the Maps of Prof. W C Kerr.

1885.



MAP
SHOWING THE RELATION OF THE
MESOZOIC FORMATION
TO THE
APPALACHIAN COALFIELD

TO ILLUSTRATE REPORT OF H. M. CHANCE.
1885.



THE DEEP RIVER COAL-FIELD

OUTLINES TAKEN FROM THE MAPS OF

CAPT. WILKES AND PROF. EMMONS

TO ILLUSTRATE THE REPORT OF H. M. CHANCE

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